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FEBRUARY, 1940

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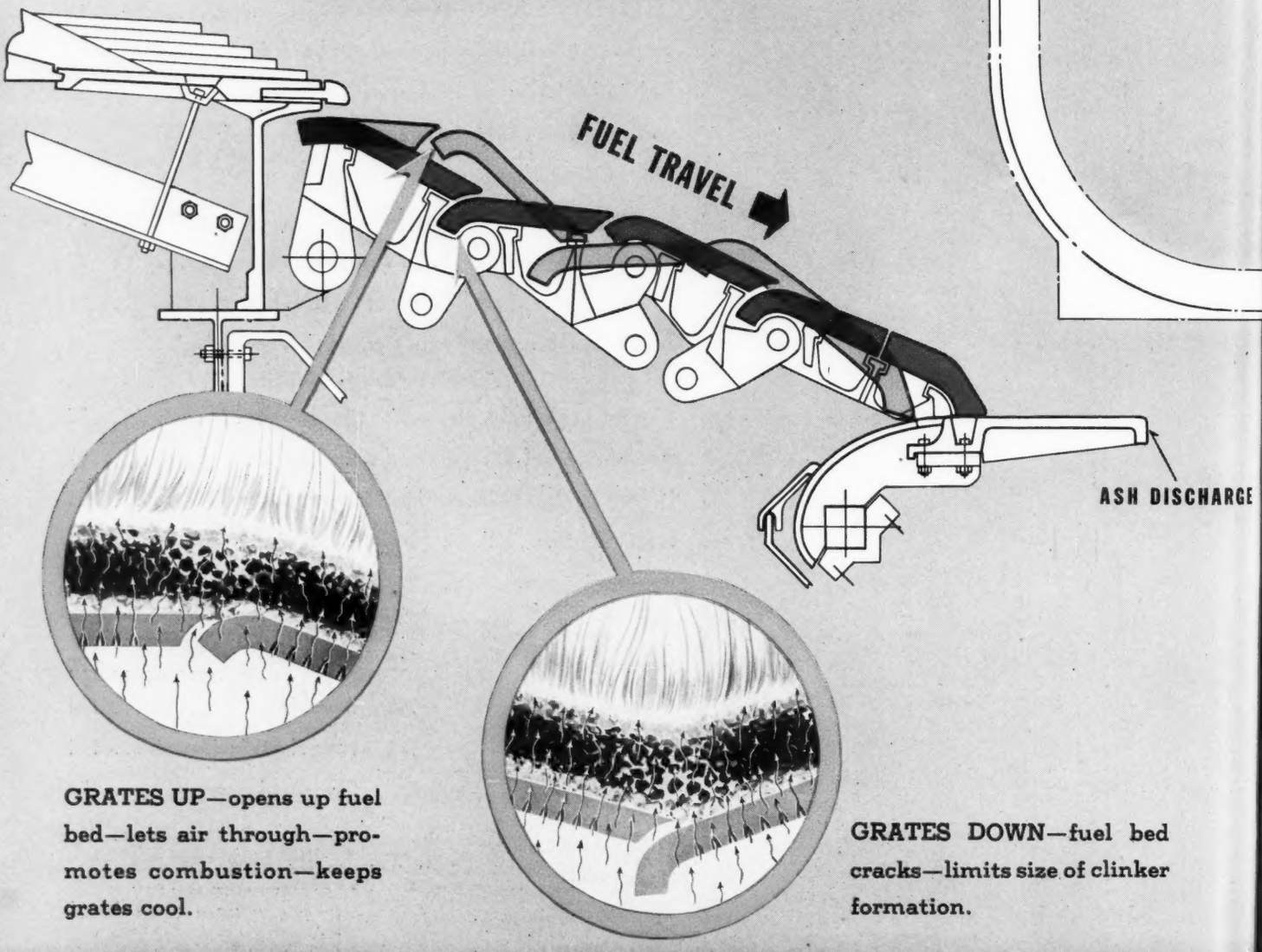
HOW *LINK-GRATE* MOTION KEEPS GRATES COOL . . . PROMOTES *BETTER* COMBUSTION



GRATES UP—opens up fuel bed—lets air through—promotes combustion—keeps grates cool.

GRATES DOWN—fuel bed cracks—limits size of clinker formation.

Westinghouse

POWER

Established 1882 PHILIP W SWAIN, Editor

Operating Man's Future

What is the future of the power engineer's job in industry, buildings and institutions? Every operator has this question in the back of his head. Our editors have thought about it, off and on, ever since Fred Low first gave *Power* its personal and practical slant way back in 1888.

At certain periods the question became more insistent. The years from 1910 to 1925, particularly, were characterized by the rapid extension of central-station service to industry, and even more to buildings and institutions. Many an old Corliss was "cashed in". Many an old operator, to whom the care of that engine was the very heart's blood of engineering, no longer had a "power plant", as he saw it.

Engineer cronies gathered in their fraternal meetings to hear the latest list of casualties and to wonder how long it would be before the power operating engineer would be a thing of the past, like the horse and buggy.

And now it's 1940. There are still plenty of power engineering jobs, and not the slightest indication that the demand for power engineers will be less in the future. Looking back, we see how easy it is to be fooled by what's right in front of your nose. "A power plant is a steam engine and appurtenances." The engineer is the man who runs the plant. If you take away the engine you destroy the plant and no longer need the engineer. This sounded like horse sense in 1910. It isn't any kind of sense in 1940.

Industry lost a lot of engines—and with them a few "engineers" who couldn't grasp the fact that engine running is a means to an end, not an end in itself—that a "power plant" is merely any aggregation of equipment that supplies all the necessary power services.

What's the net effect? Steam engines are still bought, though fewer than in the old days. The difference in this prime-mover item is more than made up by industrial turbines and diesels. Meanwhile, mass production and modern technique have created a huge demand for process steam, for refined heating systems, for refrigeration and air conditioning, for more complex elevators, for the efficient pumping of great quantities of hot and cold water, for more compressed air, etc.

Whether power is purchased, or locally generated, electrical applications made constantly greater demands on operating skill in the handling of switches, transformers, motors, M-G sets, meters, etc.

"The shut-down" power plant is an optical illusion. Engines or no engines, every large factory, building and institution has a power plant—can't run without it.

"Where are the plants?" is no longer a sensible question. We should ask, rather, "Where can we find enough men able to run the modern plants as they should be run—men who have mastered a half-dozen power services—men who know how to save dollars with proper instrumentation and control—men who can handle their work crews, the factory foremen, the brass hats, the hotel guests, the building tenants, the treasurer, the landlord."

There is not the slightest indication that the factory or institution of the future will use less power-service equipment than today. Instead, the application of such equipment increases at a rate that is almost terrifying, because it raises the question of men's capabilities, of how fast they can discard old habits and move ahead with the times. If you are a young man starting out in the field of operation, don't worry about the plants. They'll be there all right.

Worry about yourself. Can you keep up with the engineering procession? Can you think as fast as the machine designers? Can you learn to handle a complex power-service system, in its human as well as its mechanical phases? If you can, you may be sure of a good job. Industry's wheels won't turn without your plant, and the plant can't run without you.

World's Largest Sewage Plant Steam-Powered

By J M MERCER,
Sanitary District of Chicago

At Chicago's new Southwest Sewage Treatment Works, special boiler furnaces supply heat for sludge drying, destroy noxious vapors, burn dried sludge, and generate steam for turbine-driven blowers and pumps, and for auxiliary-power turbine-generators

NEW METHODS, discovered in several years of research by engineers of the Sanitary District of Chicago, solved the problem of disposing of 300 tons of solids removed in an average day's sewage treatment and led to the decision to make the new Southwest Works the first large steam-powered sewage plant. Flash drying, using 4-purpose furnaces to supply drying heat, to destroy noxious vapors, burn excess sludge, and generate steam for power needs, meets requirements of economy and freedom from nuisance.

This development provides an alternative to the sewage-sludge-gas-engine-powered plant rapidly becoming familiar to both sanitary and power engineers. Where gas engines are used, the gas formed by digesting sludge provides enough power to meet part or all of the treatment plant's needs, depending on the method of treatment, but the digested sludge presents a disposal problem. In the newly developed flash-drying system, fuel is burned to dry the sludge for use as fertilizer; if no market exists for the fertilizer, burning the dry sludge will produce the heat required for drying. In either case, the sludge is completely disposed of, and, by ingenious arrangements, without public nuisance.

Since a flash-drying sludge-disposal system includes most of the elements of a steam-generating plant, the annual cost of furnishing steam would consist largely of fixed charges on whatever additional equipment was required, plus fuel cost. Thus it seemed most economical to generate the plant's power requirements from steam, using direct turbine drive for large pumps and blowers, and driving smaller units by electric motor supplied from turbine-generators. Since the end-product of sewage treatment is a large quantity of clear water suitable for circulation, there was no limitation on use of condensing units. The combined effect of all these factors shows up in extremely low power costs, lower even than the highly favorable rates at which the Sanitary District would be able to buy the large blocks of power required.

Description of this unique plant naturally falls into three divisions: sludge disposal, power generation, and power use. From the diagram of the sludge-disposal system, it can be seen that principal drying takes place in a closed circuit. As received from the concentration tanks, the liquid sludge averages 95% moisture. Addition of ferric-chloride solution coagulates the material to permit partial dewatering on rotary vacuum filters. These reduce the moisture to about 80%. This is the point at which the diagram starts tracing the disposal process.

The 24 vacuum filters can handle 492 tons of solids per day (measured on a dry basis). They discharge the dewatered sludge or filter cake to a belt conveyor on the floor below, running to sludge mixers. Here mixing with pre-

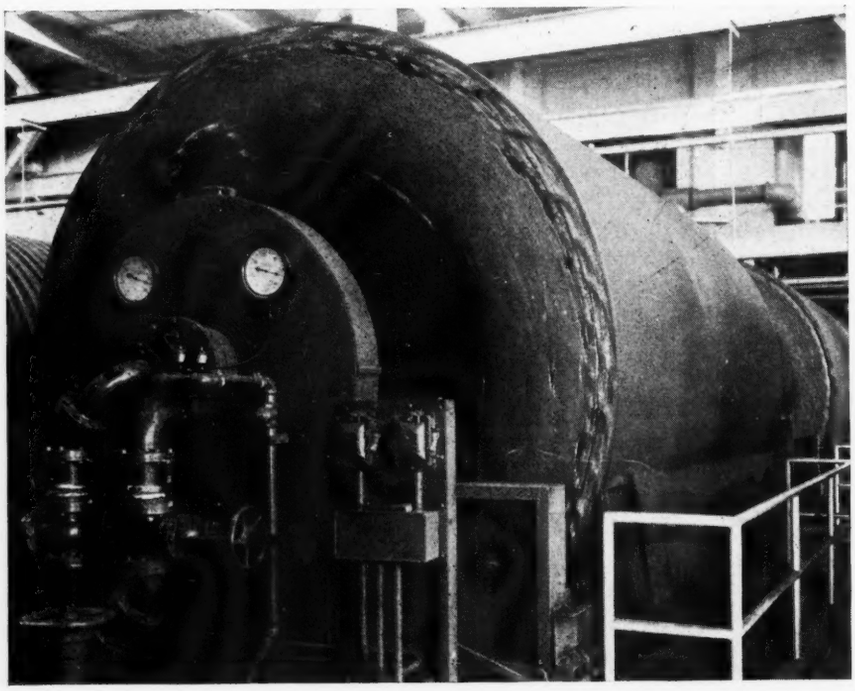
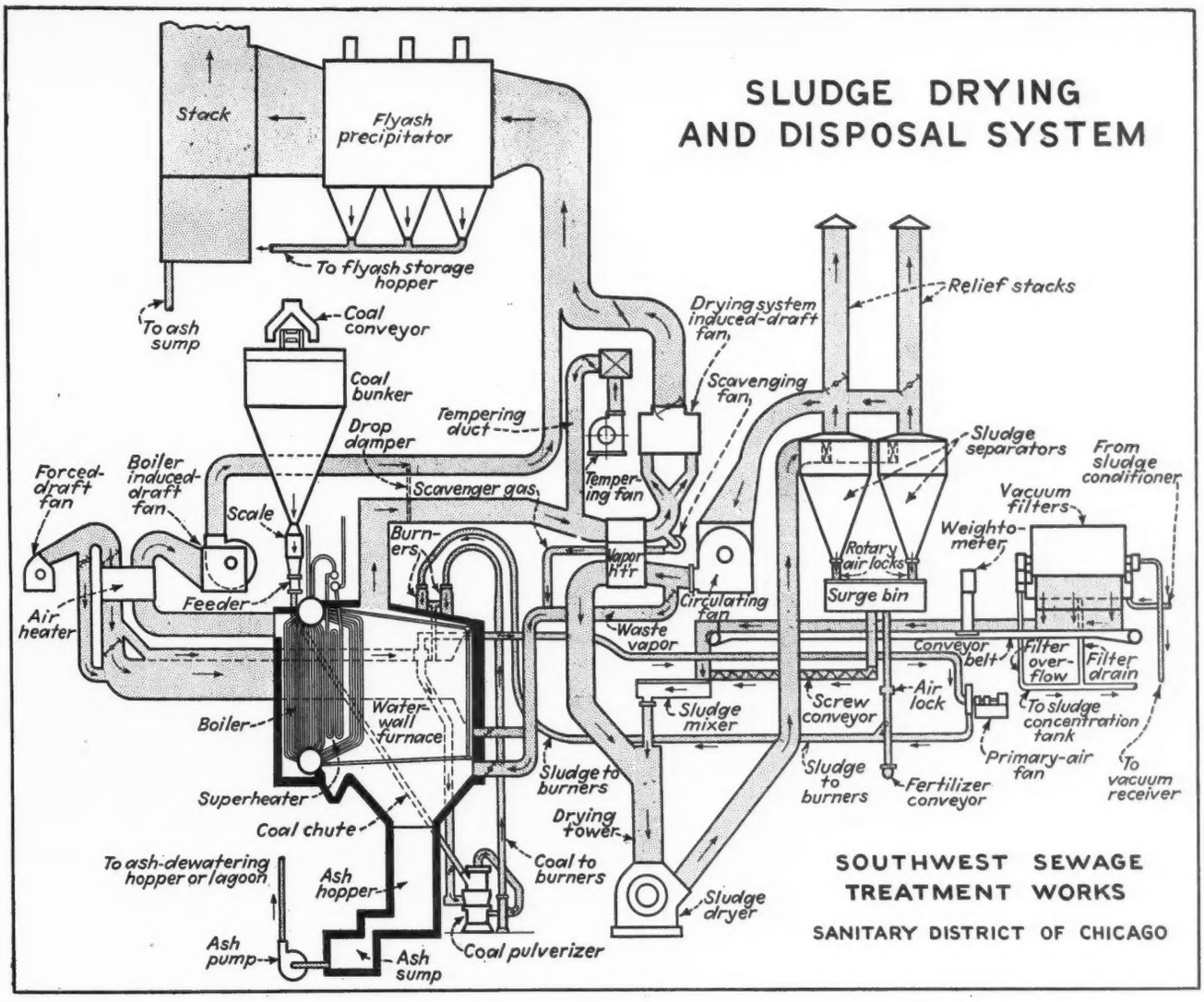


FIG. 1—One of 24 vacuum filters which dewater concentrated sludge. Filter cake, with 80% moisture, falls to conveyor belt on floor below, passing to sludge mixer



viously dried sludge gives a moisture content of 40-50%. In that condition, the sludge can be readily broken up into small particles which present the maximum surface per unit of volume, for drying in suspension. The mixer discharges the moist sludge to a drying tower where it passes into a stream of superheated (1100 F) sludge vapor and drops into the flash dryer. In the scroll-shaped housing of the dryer, which somewhat resembles a fan, the material passes between stationary and rotating bars which produce violent agitation. Moisture in the sludge vaporizes, taking heat from the vapor stream and lowering its temperature to about 300 F. The circulating fan draws the mixture of cooled-vapor and sludge into the top of the cyclone separators where the sludge, now dried to 7% moisture, passes through rotary air locks to the surge bin while the vapor continues to the vapor heater to pick up heat from furnace gases. Here the temperature is restored to 1100 F.

There are 8 drying circuits, each of

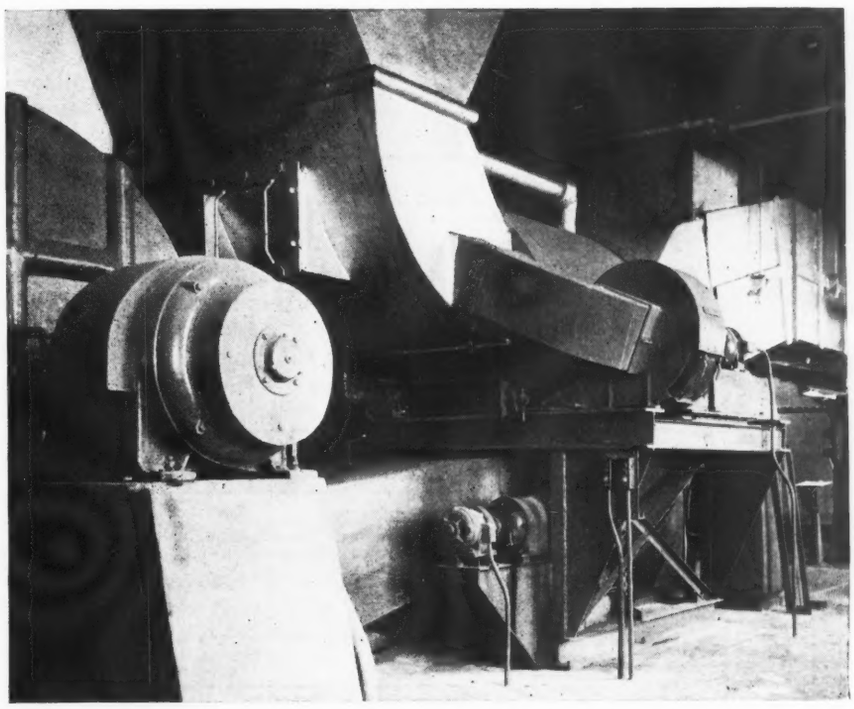


Fig. 3—Vapor heater on sludge-drying circuit: hot gas from furnace flows in top duct, sludge vapor in duct below. A scavenging fan stands in front of the heater

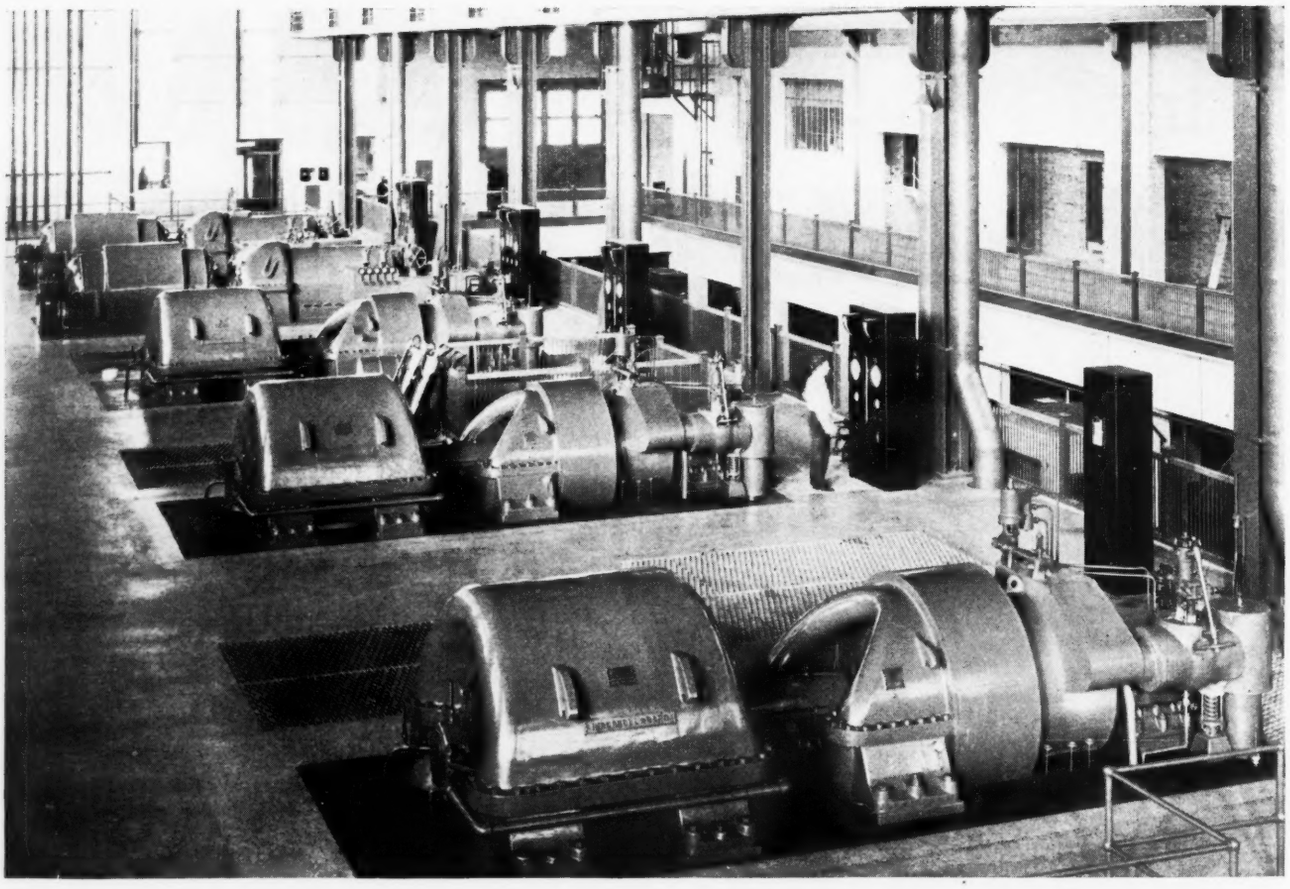


Fig. 4—On the main floor of the pump and blower house stand three 60,000-cfm blowers (foreground) and two 5000-kva turbine-generators. The four main sewage pumps, of 300 cfs capacity each, are set in a pit behind the columns at the right

which can evaporate 20,000 lb of water per hr from the sludge in suspension. The vapor thus released has a most disagreeable odor and cannot be allowed to escape to the atmosphere. Therefore, a relief duct just ahead of the vapor heater carries excess vapor to the furnaces, where passage through the combustion zone destroys the odor. This also relieves the pressure that would build up in the drying circuit.

A screw conveyor takes enough dried sludge from the surge bin to bring the incoming filter cake to the proper consistancy for drying. Another conveyor takes the remaining sludge for disposal. It is a desirable fertilizer material and the entire output has been sold for such use. At times when delivery cannot be made for sale as fertilizer, the sludge is diverted to a firing line, blown into the furnace with preheated primary air, and burned. Fuel value of the dried sludge runs about 7000 Btu per lb, which supplies enough heat to handle the drying when the vacuum filters operate to produce a filter cake with 80% moisture. When the sludge is delivered for fertilizer, the heat for drying is supplied by burning more coal.

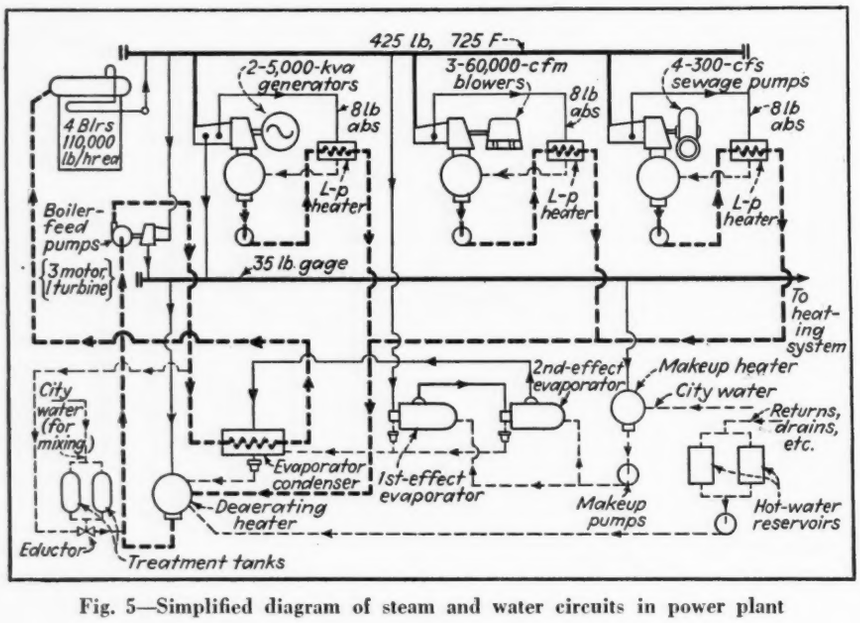


Fig. 5—Simplified diagram of steam and water circuits in power plant

Four-Purpose Boilers

Four boilers, each capable of producing 110,000 lb per hr of 425-lb, 725-750-F steam, supply the power equipment. In addition to generating steam, each furnace must be able to furnish heat to evaporate 49,000 lb per hr of water in the sludge dryer, to burn 14,500 lb of dried sludge per hr, and must pass through the combustion zone as much as 49,000 lb per hr of sludge vapor. Total water evaporated per hr by the four units may amount to 600,000 lb, made up of 440,000 lb of high-pressure steam, and 160,000 lb of sludge vapor at atmospheric pressure.

On each furnace, six burners for

powdered coal and four for dried sludge alternate in two rows in the furnace top. All furnace walls are water cooled and a water-tube slag screen is provided. Combustion space in each furnace amounts to 7900 cu ft and heating surface of waterwall and slag-screen tubes totals 1030 sq ft.

The vertical-tube, 2-drum boilers comprise 10,600 sq ft heating surface each, with an additional 3740 sq ft in the superheater. Air heaters on the furnace breeching raise combustion-air temperature to 360 F.

Coal comes by rail to a handling plant for screening and crushing before conveyors carry it to bunkers over each furnace or to an outdoor storage pile holding 12,000 tons. The bunkers deliver through coal scales to two bowl mills at each furnace.

Vapor Cools Ash

Waste sludge vapor at about 225 F enters the furnace through the front wall near the bottom. The vapor helps cool the ash before passing into the combustion zone and so gives a method of controlling slag formation. An excess of air insures complete oxidation of the organic odor-producing substances. Enough furnace gas is bled out through a duct in the furnace top, to maintain the hot side of the vapor heaters at 1500 F. This gas is tempered with room air before entering the heater. At the maximum drying load, heat extracted from each furnace exceeds 57 million Btu per hr, while heat returned to the furnace in waste sludge vapor amounts to only 3,450,000 Btu.

Hydraulic systems handle ash from both furnace ashpit and from stack hoppers; pumps force it to a dewatering hopper or to an ash lagoon. All flue gas and spent furnace gas from the drying system passes through electrostatic precipitators before discharge.

The flow diagram (Fig. 5) shows the boiler-water circuits in simplified form; auxiliary equipment and piping, plus complete interconnection and by-passing, give the system a high degree of operating reliability and flexibility. Four 16-stage pumps (three motor-driven, one turbine-driven) supply boiler feed. Condensate from the main turbines passes through individual low-pressure heaters and a single deaerating heater on its way to the feed-pump suction. Condensate from the heating system, and drips from the steam mains, enter a hot-water reservoir from which three makeup pumps deliver to the deaerator. A distilled-water tank, not shown in the diagram, connects in parallel with the deaerator; makeup lines run between the distilled-water tank and the hot-water reservoir; the deaerator overflows into the reservoir.

City water, treated, constitutes the normal source of makeup; it enters the system at a point just ahead of the makeup pumps. In an emergency, untreated city water can be fed into the hot-water reservoir. A double-effect evaporator system distills makeup water as required. The evaporators take high-pressure steam; a preliminary makeup heater takes 35-lb steam extracted from the turbine-generators. Boiler feedwater, pumped through the evaporator condenser, picks up heat from the condensing vapor, on its way to the boilers. Condensate from the evaporating system goes to the deaerating heater.

Condensing turbines drive four main sewage pumps, three blowers for aerating sewage, and two generators. Main sewage pumps can handle 300 cfs (each) at 180 rpm and 54-ft head. This requires turbines rated at 2088 hp normal load, and 2310 hp maximum. Running at 4080 rpm these units drive through double-reduction speed reducers, with double-helical gears. Pumps are single-stage, horizontal, volute type without diffusion vanes, designed to pass a 6-in. sphere.

The three blowers can each deliver 60,000 cfm of free air at 7.75 lb g, under average conditions, and 70,000 cfm at 8.5 lb maximum. A 16-stage direct-connected impulse turbine, running at 2540 rpm average and 3300 rpm maximum, powers each blower.

Reaction turbines, rated at 5550 hp each, drive the 5000-kva, 6600-volt, 0.8-pf generators supplying auxiliary power for the plant. Steam extracted at 35 lb g supplies building heating and feedwater heating (see flow diagram, Fig. 5).

Clarified sewage effluent cools all condensers; plant arrangement is such that the water flows through condensers by gravity on the way to the outfall. Passing the effluent through fine screens and then an automatically controlled chlorination cycle eliminates formation of tube films due to organic matter in the water. All condensers are single-pass surface units, fitted with steam-jet ejectors using both inter- and after-condensers. Steam extracted from each turbine at 8 lb abs heats condensate before it returns to the feedwater system.

Southwest Works is designed to treat an average flow of 400,000,000 gal. per day (620 cfs) by the activated-sludge process, using 20% return sludge and five hours aeration. Use of air lifts instead of variable-speed pumps for handling large volumes of sludge at low heads is an unusual feature of the plant design. Maximum loads of 600,000,000 gal. per day will occur during storm periods when peak loads of solids will be stored in the aeration system in order to reduce the peak demands on the sludge-disposal system. Duplicate air lifts are therefore installed on each final settling tank to handle a large volume of sludge when required.

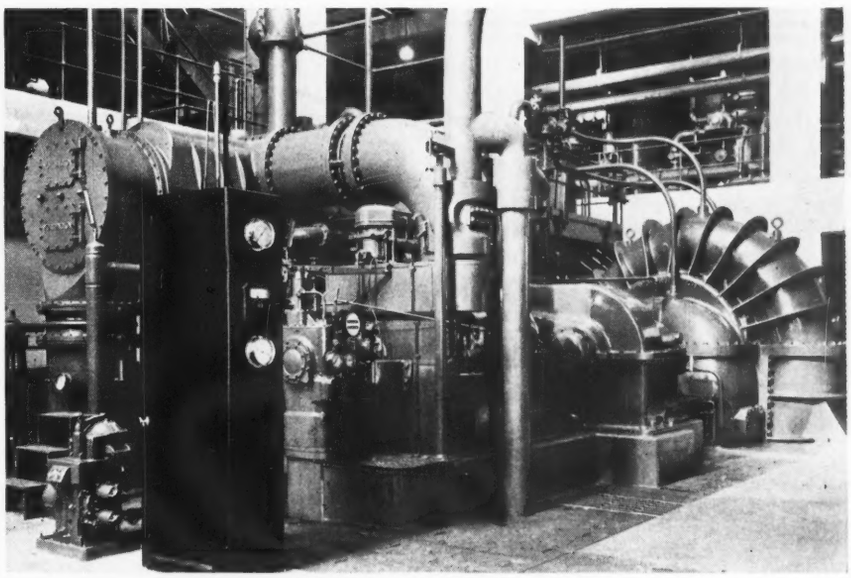


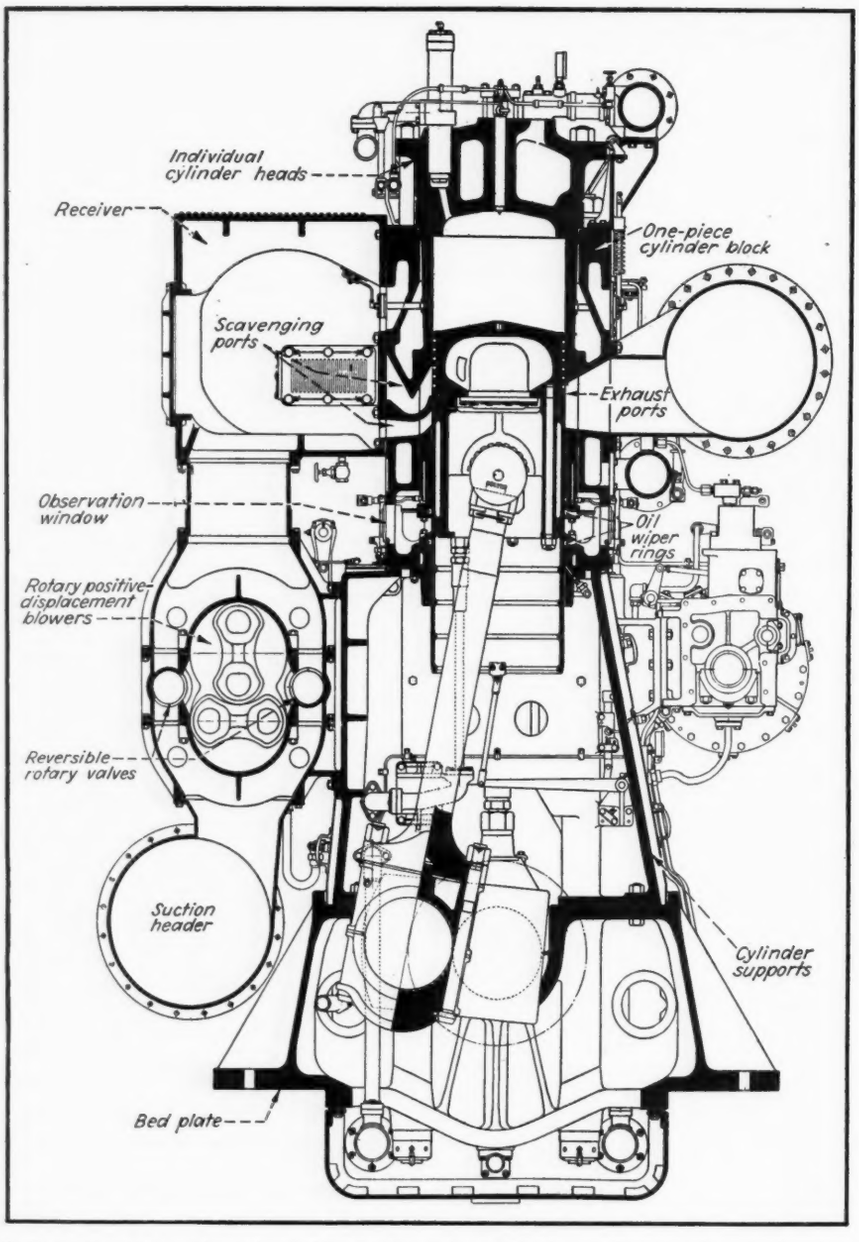
Fig. 6—A sewage pumping unit: condenser, turbine, speed reducer and pump

Design and construction of the Southwest Works was carried out by the Engineering Department of the Sanitary District of Chicago, of which W H Trinkhaus is Chief Engineer and W A Dundas is Engineer of Mechanical Design. This plant is part of work financed under a PWA loan and grant and all designs were approved by PWA engineers.

Ship Diesels Burn Heavy Oil by Solid Injection

Engines for new Maritime Commission freighters handle bunker fuels successfully on test, opening fields thought closed to mechanical injection

By GLENN C BOYER
Associate Engineer, Burns & McDonnell Engineering Co



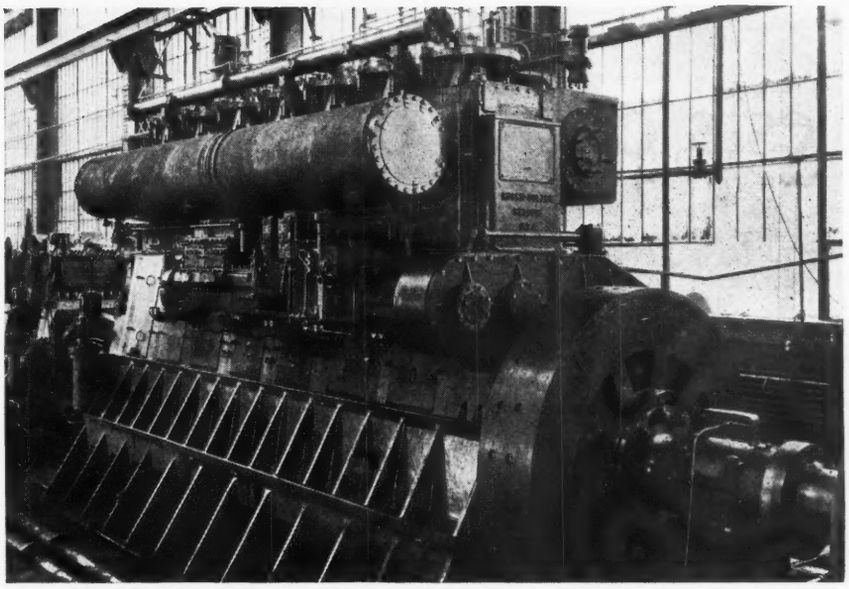
Section through engine (from front) shows fuel injection and governing equipment on right side; and common suction and scavenging air headers on left

DESIGNED to meet marine fuel-versatility requirements, engines for the new Maritime Commission C-3 cargo boats burn heavy residual oils by mechanical injection, thus opening a field of application long thought closed to engines of this type. Factory tests, plus experience with several stationary engines of similar design, indicate that efficiency of large engines measurably improves when use of solid injection eliminates the compressor required for air injection. On the test I witnessed recently the fuel analysis, after centrifuging, showed 0.993 specific gravity, 10.29% Conradson carbon, 945 SSU viscosity (at 100 F) and 3.02% sulphur.

Four Engines Drive Ship

Sixteen engines of this type, being built by Busch-Sulzer Diesel Engine Co, will power four 8900-gross-ton cargo boats. Power plant for each ship consists of 4 diesels driving a single screw through Westinghouse electro-magnetic couplings and Falk reduction gears. At 85 shaft rpm, they will deliver a total of 8500 shaft hp, with continuous overload capacity of 10%. Operation of all engines and couplings is centrally controlled.

Tests of 12 of the 16 engines indicate highly satisfactory performance, and while no official data on actual fuel rates is available, it is understood that they are approximately 0.38 lb per bhp per hr, at full load. Using the same set of injection nozzles for several engine tests gave a sufficient operating period to check difficulties that might be experienced with low-grade fuel. In addition, designers learned much from operation of a Busch-Sulzer mechanical-injection engine at Union Stockyards in Chicago, which has burned heavy oils



One of 16 two-stroke-cycle, trunk-piston, port-scavenging and port-exhausting, air-starting, direct-reversible, mechanical-injection engines set up for test at factory

for 7-8 years, and from another at the City of McMinville, Oregon (see table). Increased knowledge of injection principles and gradual improvement in design thus seem to have removed solid-injection fuel limitations.

The engine cross-section shows the 1-piece bedplate which forms two longitudinal girders connected by integral bridges carrying the lower main-bearing half-shells. These are steel, tinned and babbitt-lined, and can be rolled out without removing the crankshaft. The bearing cap, babbitt-lined, forms the upper main half. Cast-iron cylinder supports form spacers between the bedplate and the CI (cast-iron) 1-piece cylinder block, bored to take 7 alloy CI cylinder liners divided into upper and lower barrels.

Water-cooled, individual, CI cylinder heads hold upper barrels; lower barrels mount on underside of block. Bottoms of upper barrels and tops of lowers carry sectional oil-wiper rings which prevent dirty oil and gas from passing into crankcase from above, and clean oil from passing into combustion space from below. The space between upper and lower barrels opens into a chamber in the cylinder block; openings on the block are fitted with glass covers and lights so that piston lubrication may be watched.

Four rotary positive-displacement blowers, arranged in line above the suction header, deliver air to a receiver above, which opens into the cylinders by way of scavenging passages and ports. Scavenging and exhaust ports are so arranged that in downward travel the piston first uncovers the upper tier of scavenging ports; non-return valves cut off communication to the receiver. The piston next uncovers the exhaust ports and later the lower scavenging tier. This produces a moderate amount of supercharging with free exhausting and scavenging, and without risk of "blowback" into the receiver.

Working pistons consist of a forged-steel top carrying rings, oil cooled through telescopic tubes; a plain CI skirt of light symmetrical sections without openings through which wristpin lube oil could escape; and a wristpin housing attached to the top within the skirt, providing a babbitt-lined bearing for the pin. The steel-forged wristpin, hardened and ground on rubbing surfaces, has a flat-bottomed recess in the underside to form a seat for the connecting-rod top flange. The wristpin receives lubrication from the piston-cooling supply and not from the crankpin, through the rod. The entire assembly of housing, rod, and pin, can be removed without needing to drive wristpin out of tight fits in piston bosses.

Fuel-Injection System

The injection system is a modification of the Bosch type, made by Diesel Equipment Co. Simple differential needle valves, hydraulically operated by fuel-pump pressure, mount on the cylinder heads. Fuel passes to the combustion space through water-cooled atomizing nozzles. Duplicate sets of cams, for running "ahead" or "astern", operate fuel-pump plungers; the crankshaft drives the camshaft through gears. Opening a bypass valve during delivery controls fuel quantity per plunger stroke; excess fuel returns to pump suction. A Woodward governor actuates control gear varying point of bypass opening. Pumps are arranged for manual cutout of fuel delivery to any cylinder, and are connected to a Woodward overspeed governor which interrupts fuel delivery to all cylinders when engine speed exceeds desired maximum. In accordance with Maritime Commission specifications, fuel is heated, centrifuged, and reheated to about 180 F.

A single motor-driven pump serves both piston-cooling and general lubrication systems. Returns from both systems run to a sump built into the ship's structure, but oil from the two does not mix until it leaves the engine, thus minimizing accumulation of hot oil vapors in the crankcase. The pump draws oil from the sump, through a strainer, and discharges back to the engine through a filter and cooler.

COMPARISON OF FUELS BURNED IN TYPICAL HEAVY-OIL INSTALLATIONS

Fuel Sample	*1*	*2*	*3*	*4*
Heating value, Btu. per lb.	18,845	18,775	18,315	18,690
Specific gravity, at 60 F.	0.959	0.942	0.993	1.015
Flash point, F.	211	206	261	201
Burning point, F.	234	252	296	234
Acidity, %	0.018	0.030	0.004	0.037
Sulphur, %	0.94	1.24	3.02	0.78
Water, %	Trace	0.04	0.03	Trace
Sediment, %	0.15	0.11	0.12	1.10
Ash, %	0.024	0.033	0.480	0.045
Residue, % (½ hr. at 400 C)	17.42	24.48	25.06	23.11
Hard asphaltum, %	2.92	4.43	7.25	6.53
Viscosity, SSU at 100 F.	114	702	945	287
Cold test, F.	—10	2	3	2
Conradson carbon, %	5.49	5.77	10.29	11.87

1—Fuel used in Busch-Sulzer mechanical-injection engine in service 7 years at Union Stock Yards, Chicago.
2—Fuel used in Busch-Sulzer mechanical-injection engine at McMinville, Oregon, during past year.
3—Shell No. 6 fuel used for testing mechanical-injection engines for Maritime Commission.
4—Fuel used for years in successful central station equipped with air-injection engines.

Load Tests of a Combustion

By PROF DR A STODOLA
Zurich, Switzerland

First actual test results of the first combustion-gas turbine ever built for direct power generation shows a full-load thermal efficiency of 17.38%, about 19,600 Btu per kwhr

THE PRESENT-DAY possibilities of realizing a successful gas turbine, resulting from improvement of the compressor efficiency on the one hand and the availability of heat-resisting materials on the other, would have appeared unthinkable only a short time ago. The axial-type compressor, developed some seven years ago by Brown Boveri in connection with the Velox steam generator, enables the performance of the gas-turbine cycle to be improved 65% over the best result attainable with a centrifugal compressor. A further improvement of 18% has been made possible by the metallurgist's development of heat-resisting steels.

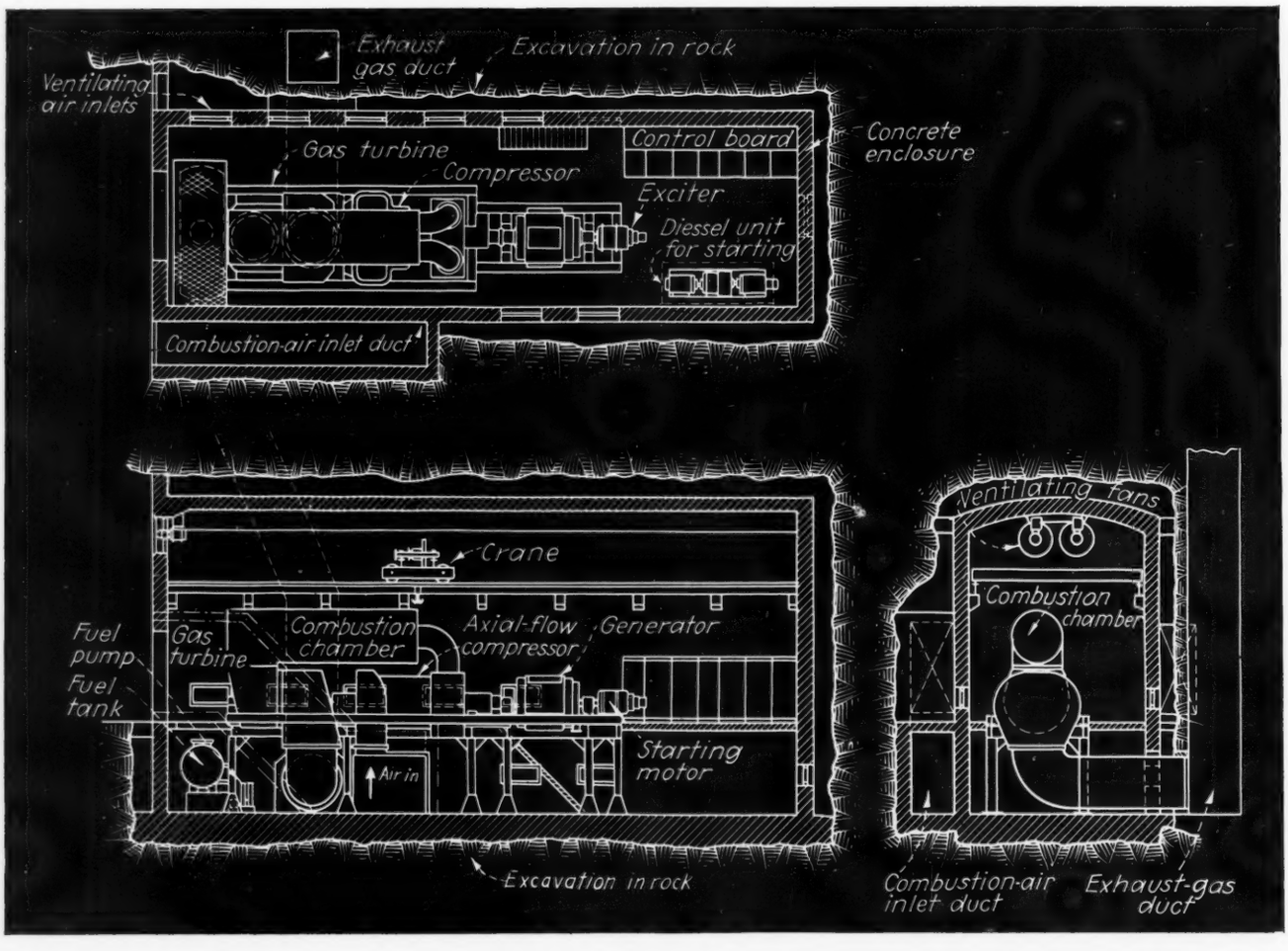
Were it not for these developments, the only possibility for the realization of the gas turbine would be that already appreciated by Holzworth in 1905, namely the explosion cycle, which was persistently pursued by him. After many sacrifices, a working explosion-turbine plant was produced by Brown Boveri in 1933.

The continuous-combustion gas turbine, however, is capable of the same or better efficiencies as the explosion type, but without complexities of valve arrangement and auxiliary equipment inherent in the latter. For explanation of theory and operation of the combustion turbine see POWER, June and December, 1939.

The turbine itself is provided with multistage reaction blading. The rotor, Fig. 2, consists of two shaft ends, each formed in one piece with the end disk, and of an intermediate unbored disk of constant-strength section, welded at its periphery. This is a well-known construction employed by Brown Boveri in steam-turbine manufacture.

The difference between the axial thrusts of the turbine and compressor is taken up by an ordinary segmental

Fig. 1—Compact power unit is installed in tunnel cut from hillside



Turbine

thrust bearing. The thermal expansion on an over-all length of turbine of about 6 ft, measured over the bearings, and with initial gas temperature of 1000 F, is appreciable, but the difference between the expansions of casing and shaft is quite small. Glands are thin alloy-steel strips caulked into grooves.

Load and governing tests were performed July 7, 1939, at the makers works in Baden, Switzerland, under the author's personal supervision with the assistance of the officially recognized Swiss Association of Steam Boiler Proprietors and of the test laboratory staff of the Swiss Association of Electrical Engineers. The calorific value of the fuel was determined by the Fuels Department of the Swiss Federal Material Testing Laboratories.

Tests Results

The fuel consumption was determined by weighing, readings being taken every ten minutes. Mean readings and efficiency values are recorded in concise form in the table.

A preliminary test using a standard nozzle determined the exhaust-gas quantity of the turbine. This enabled, after deducting the weight of fuel fired, calculation of speed-volume characteristic of the compressor. Average gas temperature at the turbine was also determined analytically with greater accuracy than local temperature shown by thermocouples.

The full-load thermal efficiency of 18.04% at the generator coupling, could, of course, be improved by the addition of an air preheater or other means. The builders, however, deliberately refrained from including any heat-recovery apparatus to improve economy, as the unit is intended for use as a standby bombproof plant to run only a few hours per year. No increase in investment could be justified by higher efficiency.

The extraordinary simplicity of the plant thereby obtained, together with the relatively high efficiency achieved without heat-recovery apparatus, is likely, in many practical cases, to be the deciding factor in favor of installing a gas turbine. In addition to the simple and reliable design of the few main components, namely compressor, combustion chamber and turbine, there is the great advantage that no cooling

TEST RESULTS

General			
Test number	1	2	3
Time	9:25–9:40	10:10–11:10	11:25–11:55
Duration, min	15	60	30
Barometric pressure	732.7 mm Hg = 14.177 lb per sq. in.		
Speed, rpm	3,020	3,020	3,030
Net calorific value of fuel oil, Btu. per lb	18,257	18,257	18,257
Efficiency			
Terminal output of generator, kw	0	4,021	3,057
Power at generator coupling, kw	0	4,184.3	3,193.8
Fuel quantity, lb. per hr	1,812	4,338	3,649
Specific fuel consumption, lb. per kw. hr	.....	1.078	1.193
Thermal efficiency at terminals, %	.....	17.38	15.67
Thermal efficiency at coupling, %	.....	18.04	16.37
For inlet air temperature of 68 F., the above efficiency values correspond			
to a speed, rpm	.....	3,000	3,000
to a terminal output, kw	.....	4,000	3,026
to a turbine inlet temperature, F	615	998.5	890.5
Compressor			
Temp. at compressor inlet, F	73.6	77.4	78.6
Temp. at compressor outlet, F	357.6	396.8	393.0
Abs pressure at compressor inlet, lb. per sq. in.	14.056	14.056	14.056
Abs pressure, compressor outlet, lb. per sq. in.	53.72	61.69	60.26
Pressure ratio	3.82	4.38	4.28
Weight of air, lb. per hr	496,436	491,264	498,347
Adiabatic power, kw	8,650	9,710	9,660
Efficiency (deducting bearing friction, etc.), %	84.4	84.6	84.9
Coupling output, kw	10,250	11,480	11,380
Gas turbine			
Temp. at turbine inlet calculated from fuel F.	627	1,025	917
Temp. after gas turbine, F	325	532	487
Abs pressure at gas turbine inlet, lb. per sq. in.	52.8	60.77	59.31
Abs pressure, gas turbine outlet, lb. per sq. in.	14.21	14.22	14.215
Pressure ratio	3.7	4.25	4.15
Gas weight, lb. per hr	198,248	495,602	501,996
Adiabatic power, kw	12,000	17,725	16,460
Coupling output, kw	10,250	15,664.3	14,573.8
Efficiency from power, %	85.4	88.4	88.4
Over-all efficiency of the turbo-set			
Tot. eff. = Comp. eff. × turb. eff., %	72.1	71.8	75.0

It is particularly fitting that Dr Stodola, former professor of mechanical engineering at the Swiss Federal Institute of Technology and since 1929 a consulting engineer of world-wide prominence, should supervise and publish the first test results of a practical gas turbine. Besides being the author of a well-known text on steam and gas turbines, he has long been associated with the development of the combustion gas turbine. Now over 80 years old, Dr Stodola has lived to see research make possible a new prime mover, visible result of what once was an unrealizable dream

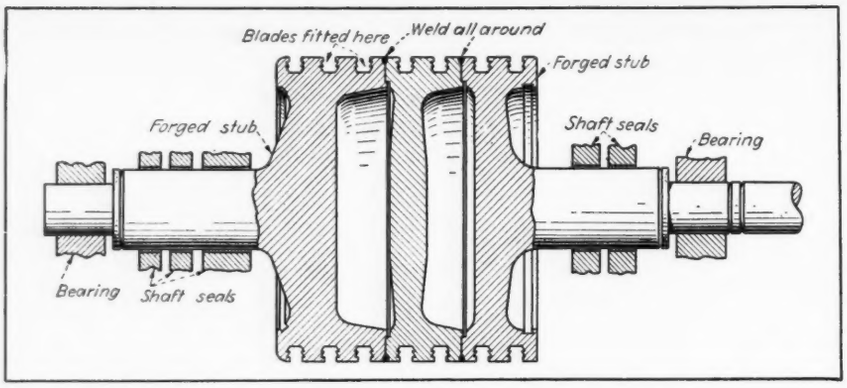


Fig. 2—Detail of welded rotor construction

water is required. Location of plant is therefore independent of water supply. Other factors of equal importance are the low capital cost and extremely small space requirements with attendant reduced construction costs. Cubic space requirements of this installation, Fig. 1, 70 x 33 x 20 ft, are the lowest ever attained for a complete stationary plant of this output.

Dr. Adolf Meyer* has rightly drawn attention to the following applications where gas turbines of the type described or of slightly modified design can be used to advantage:

1. Standby and peak load sets for electric power generation, or where cooling water is lacking.

2. Chemical process requiring compressed air where power can be developed from hot waste gas.

3. Supplying air for blast furnaces, using furnace gas as fuel.

4. Locomotive drive as alternate to steam or diesel electric.

5. For ship propulsion, especially high-powered naval units such as torpedo boats and destroyers.

In regard to future development, the following possibilities for raising efficiency are worthy of note:

1. Air preheating at the outlet of the compressor by hot exhaust gas.

2. Fractionalized combustion, by subdividing the gas turbine into two or more stages and reheating the gas in intermediate combustion chambers by additional injected fuel. Also, intercooling of the air compressor.

3. Improving efficiency at fractional loads by dividing the turbine into two units, one for power generation at fixed speed, the other driving the compressor at its most favorable speed.

4. Raising the initial temperature above 1000 F. This may be expected in the near future.

When one considers that, for every 1% improvement in the efficiency of the turbine or of the compressor due to improvement in blade shape, the over-all efficiency is raised 4% or 3% respectively, one can understand why the gas turbine offers promising possibilities meriting the attention of prime-mover designers and industrial leaders.

* Institution of Mechanical Engineers, London, Feb., 1939.

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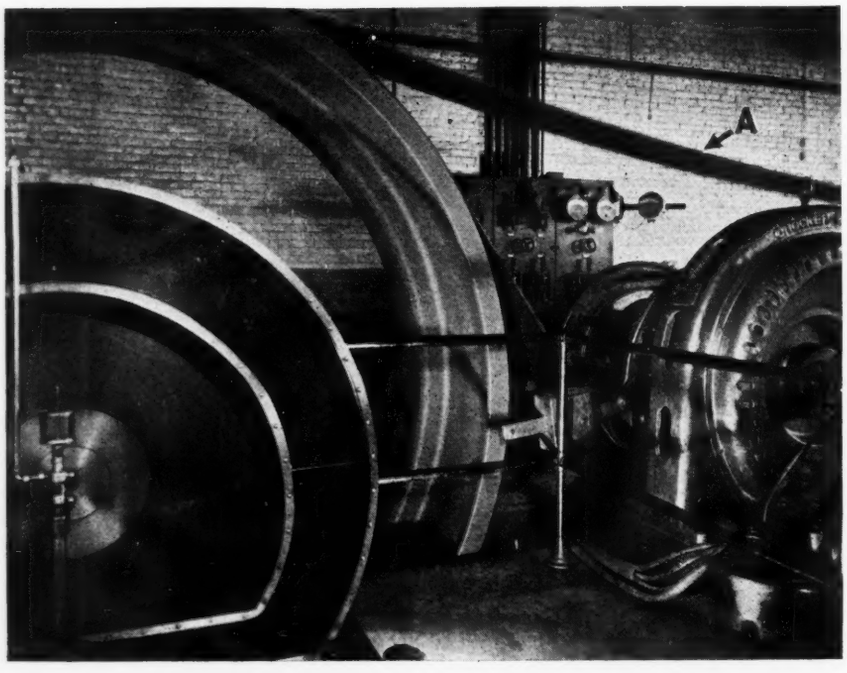
Three Belts Run on One Flywheel

By W F O'REGAN
Dorchester, Mass.



READERS of the two articles on "Sweet-Running Belts", June and September POWER, may be interested in the belt set-up at our plant. From the 12-ft flywheel on our 500-hp Rice & Sargent engine, 22-in. belt with gravity-type idler runs to a 180-kw ac generator. The generator pulley is 24 in. diameter, giving a pulley ratio of 6. This is quite high for such a short-center drive, as there is but 3 ft clearance between the flywheel and pulley.

A long-center rider belt (*A*), 18 in. wide, runs on top of the 22-in. belt on the flywheel and drives a line shaft connected to a 37.5-kw dc generator.

The engine flywheel is 5 ft wide on its face and has two crowns, one for the two belts just mentioned and the other for a 30-in. belt driving a mill lineshaft (not shown in photo). From the lineshaft, power is taken off by about every conceivable type of mechanical-transmission equipment.

Considering the conditions under which this set-up operates, it has given very little trouble. Some of the belts have been on the job for 30 years.

Simple Meter Charts Blowdown

Measuring muddy fluid takes no gilt-edged gallon counter. An orifice, a length of oversize pipe and a recording pressure gage tally true total

By A A MARKSON
Research Engineer, Consolidated Edison Co, New York

WITH CONTINUOUS BLOWDOWN, now common practice, heat recovery is practical and measurement of water quantity is desirable for calculation of heat balance as well as knowledge of boiler-drum conditions.

Since no extreme precision is called for, the measuring device ought to be simple and not subject to troublesome maintenance from muddy water. A meter accurate to within 3 to 4% will keep station over-all figures within a fraction of one per cent.

Sediment Is Problem

High maintenance on a paddle-wheel meter, originally furnished with the continuous blowdown system in Kips Bay Station of the New York Steam Corp, occasioned development of the meter shown below. Solids in the water rendered the original meter inoperative in about one week of service, during which period accuracy steadily decreased. A recording V-notch meter would have been satisfactory but conditions hardly warranted a relatively high-priced meter. Instead, a recording device was designed and constructed on the elementary principle that water velocity through an orifice is proportional to square root of head on the orifice.

Blowdown passes through a heat exchanger and throttling valve into the meter. The meter consists of a section of pipe with an orifice discharge, the bottom of the orifice being flush with the bottom of the pipe. No sediment will then build up in the pipe during operation. A recording pressure gage is connected to the pipe chamber, so that the gage measures the pressure head acting on the orifice. A vent pipe and relief valve release trapped air and protect against accidental overload.

In effect, this apparatus records pressure on one side of an orifice, the other side being at atmospheric pressure. Using a chart scaled off as the square root of the pressure (instead of the standard pressure chart supplied with the instrument) converts to flow readings. Such charts, commercially available in many ranges, are interchangeable with standard pressure charts. Chart readings will be proportional to the square root of the reading of the pressure pen, and consequently actual flow can be read directly. Integrated quantities are obtained by averaging hourly readings or by using a square-root planimeter.

To illustrate the design of a particular meter installation, assume that maximum blowdown will be 50,000 lb per hr. To function as a true orifice meter at low rates of flow, the recording pressure gage must have sufficient range so that the meter pipe will flow full at the lowest rate of flow encountered. Assume a 0-to-30 lb-per-sq-in. recording pressure gage. By use of the formula:

$$V = C \times \sqrt{2gh}$$

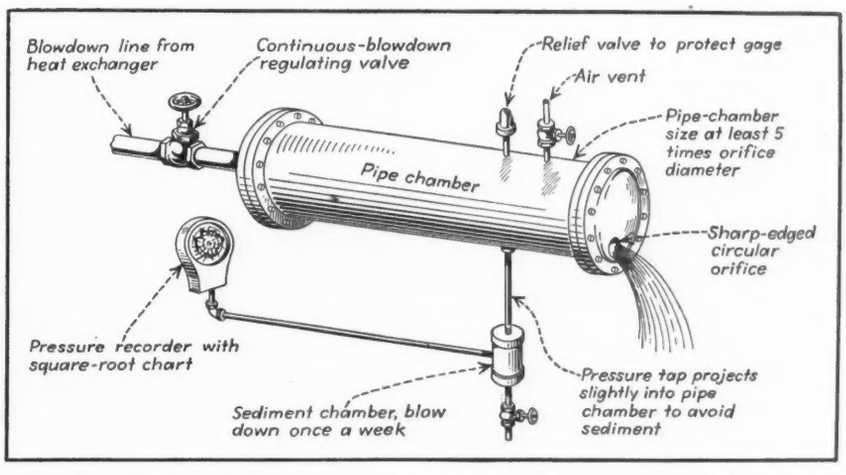
where: V = velocity in ft per sec
C = orifice constant, usually 0.6
g = 32.2
h = head of water in ft,

the proper sized orifice may be found to pass 50,000 lb per hr at 30-lb pressure, which corresponds to the gage capacity. All that is necessary to complete the meter is to use a 0-to-50,000 square-root chart on the pressure gage. The rate of flow will then be read directly. To change the capacity of the installation, design a new orifice and use a new chart or a new chart factor.

To avoid difficulty with mud, a sediment chamber should be placed between meter pipe and pressure gage. The pressure tap can well be made slightly re entrant in the bottom of the meter pipe for the same reason, but if so, the end of the pressure tap should be cut true. Blowing down the sediment chamber once a week will probably be found quite sufficient. Air should be vented occasionally.

Size of meter pipe depends upon maximum quantity of blowdown the meter will ever be expected to record. The diameter of the pipe ought to be at least 5 times the diameter of the largest orifice that may be installed, because, with this ratio of orifice and pipe diameter, correction for the velocity of approach may be neglected. Pipe length should be at least 10 times this diameter. The discharge coefficient of the sharp-edged orifice (C in the formula above) may be taken as approximately 0.6, although this may vary for different installations.

While the meter described was constructed to measure blowdown, this device can be used to measure any fluid being discharged to atmosphere.

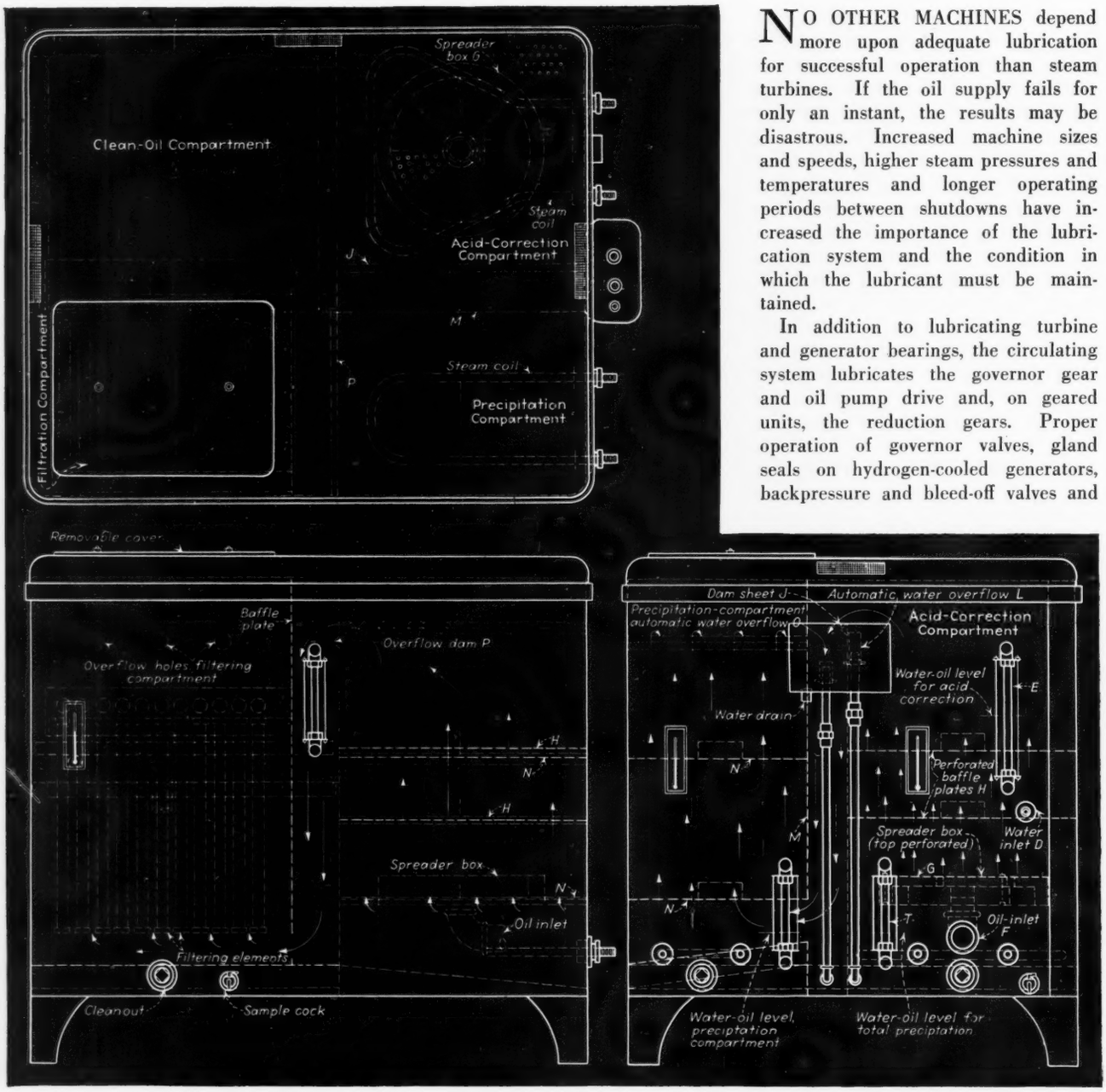

Blowdown line from heat exchanger
Continuous-blowdown regulating valve
Relief valve to protect gage
Air vent
Pipe-chamber size at least 5 times orifice diameter
Pipe chamber
Sharp-edged circular orifice
Pressure recorder with square-root chart
Pressure tap projects slightly into pipe chamber to avoid sediment
Sediment chamber, blow down once a week

Square-root chart on ordinary pressure recorder reads flow directly. Sediment does not affect accuracy if kept out of meter by chamber and blowdown arrangement shown

Turbine Oil Conditioned by Acid Correction

By E M MAY
Lubrication Engineer, S F Bowser & Co, Inc

How does turbine oil get contaminated? What is acid correction and how does it work? What are the results? Here are answers to these and other questions



Turbine-oil conditioner consists of acid-correction (water-treatment), precipitation, filtration and clean-oil compartments

NO OTHER MACHINES depend more upon adequate lubrication for successful operation than steam turbines. If the oil supply fails for only an instant, the results may be disastrous. Increased machine sizes and speeds, higher steam pressures and temperatures and longer operating periods between shutdowns have increased the importance of the lubrication system and the condition in which the lubricant must be maintained.

In addition to lubricating turbine and generator bearings, the circulating system lubricates the governor gear and oil pump drive and, on geared units, the reduction gears. Proper operation of governor valves, gland seals on hydrogen-cooled generators, backpressure and bleed-off valves and

vapor exhausters may also be dependent upon the lubricating-oil system. On high-temperature, high-speed machines, the oil not only has to lubricate the bearings but must also dissipate large quantities of heat that flow to the bearing from the steam.

On some turbines, to guard against fire hazards from oil leaks, the high-pressure oil piping is placed inside the low-pressure return lines. Oil lines are assembled in place by welding, making dismantling for cleaning practically impossible. On other turbines, oil passages are cored into bearing and governor casings. These conditions make it necessary to maintain the oil in clean and good condition at all times so that oil passages will not become plugged and require an expensive cleaning job.

Oil Impurities

Moisture finds its way into turbine-lubrication systems from leaks through sealing glands, condensation from the atmosphere on the surface of cooling coils and sump tanks, gearing and bearing casings. Water alone is not injurious to clean oil, but will in many instances cause corrosion of finely machined and fitted parts of governing mechanisms.

Metallic oxides, dust, flyash and other solids find their way into the lubrication systems, no matter how carefully they are built and operated. Water combined with these products in the presence of air and heat promotes oxidation which may form a brownish or light-colored sediment that adheres to cooler tubes and any relatively cool surface such as walls of bearing housings, sumps and pipes.

Many of the newer turbine oils contain agents that retard oxidation and its resultant formation of organic acids and emulsions. Such lubricants have long life when kept free of impurities. Metallic oxides and other impurities tend to consume these agents in the oil, leaving the lubricant without protection against acid and emulsion formation. Other turbine oils having natural oxidation-resistant and anti-acid-formation qualities may show a gradual increase in acidity, which if not checked tends to precipitate wax-like deposits in the system and may have a strong affinity for moisture and form emulsions.

Emulsions, for all practical purposes, may be defined as a mixture of liquids, solids, water, air, etc, insoluble in one another, ranging from a milky solution to a dark liver-like substance found in the bottom of sump tanks. Keeping oil free of water-soluble acids, water and colloidal solids, prevents formation of emulsions.

Turbine oils are being produced that resist oxidation to a very high degree. They show a stubborn resistance to acid and emulsion formation, but they cannot, however, prevent foreign impurities, water, metallic oxides, etc., from getting into them. These must be controlled or removed by a system of purification.

Several methods of controlling or removing the impurities in turbine oil are in use. These include adding makeup oil, withdrawing part of the oil from the system and replacing it with new, batch filtration, continuous filtration or centrifuging, a combination of these methods and oil conditioning. In the conditioner, part of the oil in service is withdrawn from the lowest point in the system, washed in thin films by hot water maintained clean, passed through a precipitator, filtered at a very slow rate and returned, without aeration or turbulence, clean and dry to the turbine lubricating system.

Oil Conditioner

The figure shows plan and elevations of the Bowser oil conditioner, arranged in four compartments: washing, precipitating, filtering and clean-oil. The washing or acid-correction compartment is filled with hot water to the level indicated on gage glass *E*. A needle valve in water inlet pipe *D* continually admits a very small amount of water, when treating oil, to maintain a constantly changing supply of water in the compartment. Water in this compartment is kept at the proper level automatically by overflow *L*.

Oil coming from the turbine is admitted through inlet pipe *F* into spreader box *G*. Here, the oil spreads out and passes up in fine streams through perforations in the spreader box cover. Removable baffle plates *H* break up the rising columns of oil to insure thorough washing. As the oil passes slowly up through the water and baffle plates, the large solid particles are precipitated out, entrained water is given up and water-soluble products of oxidation are dissolved.

When the washing compartment is full, the oil gently overflows into the precipitation compartment. Oil entering this compartment flows down around vertical baffle plate M to the bottom of the compartment. From here it again rises slowly and flows up through perforated baffle plates *N*.

These plates help to remove any entrained water and break up unequal currents, permitting slow and uniform rise of the oil column. Any entrained water is precipitated down to the bottom of the compartment. An automatic overflow *O* maintains a constant low water level in the compartment.

Oil from the precipitation compartment flows over dam *P* and down to the bottom of the filtering compartment. From here, the oil rises slowly through the fabric-covered filtering units where the fine solids impinge on their surfaces. As flow through the filtering elements is under no appreciable pressure or agitation, fine solids coalesce and either cling to the surface of the filtering elements or drop off and precipitate to the bottom of the compartment where they may be readily withdrawn. The washed and filtered oil then passes to the clean-oil compartment and is returned to the turbine-lubrication system.

Steam-Heating Coils

Steam-heating coils in the washing and precipitating compartments keep oil temperature at 150 to 160 F, which is the most satisfactory for conditioning treatment. Provision is made so that the water level can be drawn down in the washing compartment. Then, this becomes an additional precipitation compartment and the conditioner is operated this way when oil washing is not required.

Here are two examples of how oil quality can be maintained by proper conditioning: Oil, when new, in a 30,000-kw turbine, had a viscosity of 155 at 100 F, a neutral number of 0.02, a saponification number of 0.07 and a steam-emulsion number of 30. At the end of nearly 17,000 hours of operation, these characteristics were 155, 0.03, 0.15 and 149 respectively. On a 15,000-kw turbine, after over 17,000-hours operation, the oil viscosity showed no change, neutral number increased from 0.01 to 0.028, saponification number remained at 0.07, and the steam-emulsion number increased from 30 to 120.

Preventive Maintenance

The production of a kilowatt-hour at the lowest possible cost should be the aim of every power engineer. Plant economies demand that turbines be operated continuously for long periods, and that inspection-down time be as short as possible. Preventive maintenance that reduces down-time is practical economy. This applies particularly to the lubrication system, which is one of the most vulnerable features of operation. Thus, it's good common sense to maintain continuously the widest possible margin of safety in the lubricating-oil system.

Portland Acid-Cleans Boiler

By D L BROWN, W E BRIGGS and C E CORYEA
Portland (Oregon) General Electric Co

Pitted boiler tubes at Station L were conditioned for painting by cleaning with inhibited acid. Procedure detailed here, if carefully followed, gets results without harm to metal

THIS ARTICLE REPORTS method and results of removing scale and corrosion residue from the internal surfaces of a Babcock & Wilcox 16,600-sq-ft, 4-drum, bent-tube boiler using inhibited muriatic acid. Reasons for this cleaning are found in the following 3-year history of the boiler.

In the Fall of 1936, a corrosion hole in a condensate line entering the surge tank caused large quantities of air to be siphoned through the supply-tank water and this aerated water caused severe pitting of tubes of one boiler. Although an air leak was known to be present, it was not found until a thorough investigation located a hole just under the cover of the surge tank. Other boilers were not affected because their feedwater did not pass through this tank.

Painting Tubes

To prevent the corrosion pits from becoming deeper, condensate has been treated with sodium sulphite to remove oxygen. In 1937, the tubes were turbined and painted with Apexior which has been used in boiler drums at Station L for many years. This paint job, however, was believed imperfect because of the impossibility of cleaning the deeper portions of the tube pits with a turbine tube cleaner.

During 1938, one of the corrosion spots penetrated a tube and caused a leak which was repaired by welding. Fearing that other spots might develop into holes, a search for a better method of cleaning the tubes was undertaken. At this time the boiler manufacturer released a report concerning the use of inhibited acids for cleaning scaled and corroded metal, setting forth some of the principles in use for many years in the cleaning of small equipment, such as diesel-engine cooling jackets, and recommending a procedure for boilers.

This article is practically a verbatim report of the actual operation of cleaning a large boiler. We print it with the author's warning that acid cleaning involves hazards if undertaken without accurate foreknowledge of internal boiler conditions and a well-planned procedure

Inspection in April, 1939, showed the 2-year-old coat of paint in fairly good condition but signs of corrosion activity in at least one pit, probably due to poor cleaning before painting. This led to trying acid cleaning before repainting.

In cleaning steel with acids, certain inhibitors added to the acid solution greatly retard the action of the acid on sound metal but have practically no effect on the solution of scale and oxides. Although some common substances such as tannin and barium chloride are known inhibitors, the purchase of a commercial trade-marked inhibitor obviated the necessity of evaluating the ordinary inhibitors by test.

Data on the inhibitors manufactured by several large and reliable companies, Table I, were obtained and Hibitite selected on the basis of speed of delivery rather than technical performance.

Recommendations of both boiler and inhibitor manufacturers called for use of a 5% acid solution for a 20-minute interval, but this high acid concentration would be expensive in a boiler of large water capacity and the short time period would not permit proper handling of the acid solution. Consequently, laboratory experiments were made to determine the least concentration of acid that would do a thorough cleaning job, and the time and temperature required with the low acid concentration.

Short pieces of corroded boiler tubing were partially submerged in a controlled-temperature acid bath in the laboratory. In most of the tests, the outside surfaces of tube specimens were machined and polished to permit visual inspection of possible pitting action on good metal. At the same time, operators observed effectiveness of the acid on the corroded interior surface.

Test Results

The tests indicated that a mixture containing 1% muriatic acid (HCl) in water, together with a quantity of Hibitite equivalent to one lb of dry powder per 115 lb acid, would not cause an appreciable loss of metal when exposed for 5 hr at 130 F. Such treatment was found to remove all but very dense rust coatings, and the latter were so loosened that rubbing would remove them.

Acid-cleaned metals rust almost in-

TABLE I

Inhibitor	*Manufacturer*
HIBITITE—	Monsanto Chemical Co, St. Louis, Mo.
RODINE—	American Chemical Paint Co, Ambler, Pa.
GRASSELLI No. 8 & No. 3—	E I duPont de Nemours Wilmington, Del.
FERRITRAL—	E F Houghton & Co, Philadelphia, Pa.

stantly when rinsed in water containing dissolved oxygen. This, of course, prohibits critical examination of the cleaned surface. To eliminate rusting of laboratory samples, after removal from the acid bath, they were quickly submerged in a 5% solution of soda ash (sodium carbonate), quickly rinsed in water, and transferred immediately to a bath of denatured alcohol containing a small quantity of non-evaporating ethylene glycol (Prestone). Removal from the alcohol bath and quick drying left a thin protective film of ethylene glycol on the metal and prevented corrosion of the cleaned surface for several weeks.

Examination of laboratory-treated specimens indicated that mill scale and corrosion scale could be loosened from the base metal but would not disengage from the metal surface unless the acid action was violent or mechanical brushing was applied. Particles of scale, loosened by the acid but not dislodged, would attach themselves to the metal again by a corrosion bond if the sample was rinsed in water. However, nearly all the scale particles would be dislodged if the acid-treated sample was immediately dipped in sodium-carbonate solution without intermediate water rinse. Tenacious scale particles were removed by release of carbon-dioxide gas on contact of the residual acid under the scale with the carbonate solution. Efficiency of the procedure was sufficient to warrant its use in the actual cleaning of the boiler where mechanical rubbing of the surface during acid treatment would have been impossible.

Because of the large size and water capacity of the boiler, special methods of handling the cleaning and neutralizing chemicals were necessary. In addition to chemical-handling problems in the boiler room, neutralizing the acid solution before discharge to the Willamette River, a game-fish stream, required special consideration.

Circulation of Solutions

Circulation of the cleaning and neutralizing solutions in the boiler was accomplished by an all-iron centrifugal pump, 6-in. suction, 3-in. discharge connected to a 30-hp motor. The pump suction line was coupled to three interconnected 50-gal oil drums with a short line containing a gate valve to allow throttling of the intake, Fig. 1. At a point between gate valve and pump, a 1-in. iron pipe was attached and run upward to the acid-storage deck where it was fitted with four light-weight ¾-in. rubber hoses for sucking acid from the carboys.

Pump discharge, connected to the main blowoff header, supplied solution to all parts of the boiler simply by opening main and water-wall blowoff valves. Overflow from the top steam drum was provided for by removing three safety valves and attaching vent risers to the nipples, each vent pipe having an opening at its base from which fire hoses carried overflow liquid back to the pump-supply tanks. Vents were constructed of 12-ft lengths of 6-in. pipe and allowed escape of hydrogen and carbon-dioxide gas at a convenient point, thus reducing foaming at the pump-supply tanks.

Rubber-lined fire hose was used for the overflow lines because hose was found much cheaper than the purchase and installation of a pipeline, even if the hose were irreparably damaged by the cleaning solutions.

Original plans called for neutralization of the entire quantity of acid while held within the boiler but this scheme was abandoned when an available natural sink hole was discovered in a dry river inlet and its suitability for an acid dump was realized. The river inlet is the mouth of an old stream used for an ash dump. It was converted to a dry basin by constructing a low earth dam across the mouth of the inlet. Into the basin thus formed the boiler blowoff line was run for draining the acid solution.

Inspection of the boiler before acid cleaning showed much of the old paint coat intact on the tubes. Since the mild acid treatment contemplated would have little effect on the paint coating, it was removed with tube turbines. This mechanical precleaning prepared the surfaces so that uniform action by the acid might be expected.

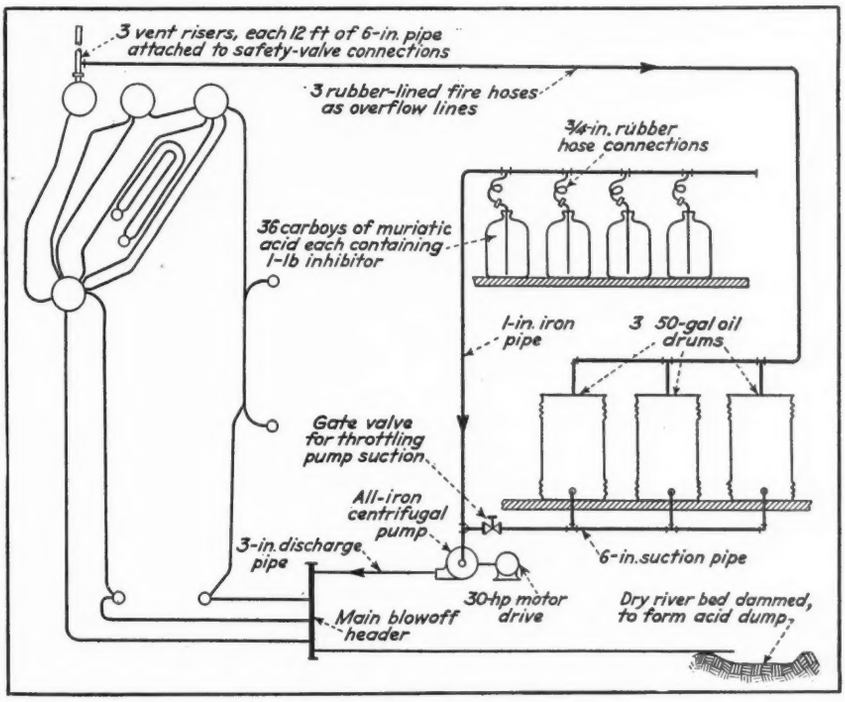

3 vent risers, each 12 ft of 6-in. pipe attached to safety-valve connections
3 rubber-lined fire hoses as overflow lines
¾-in. rubber hose connections
36 carboys of muriatic acid each containing 1-lb inhibitor
1-in. iron pipe
3 50-gal oil drums
Gate valve for throttling pump suction
All-iron centrifugal pump
3-in. discharge pipe
6-in. suction pipe
30-hp motor drive
Main blowoff header
Dry river bed dammed, to form acid dump

Fig. 1—Water circulation maintained by all-iron pump from blowoff line to upper drum while acid is added and then neutralized with soda ash

The Actual Cleaning

Actual operation of cleaning began by placing 36 carboys of 18 deg. Beaumé muriatic acid on the firing floor above the circulating pump. Three men, equipped with rubber gloves, goggles, wet-sponge aspirators and hip boots, siphoned one gallon of acid from each carboy into a 2-gal earthenware crock, mixed in one lb of Hibitite and poured the mixture back into the carboy through a large glass funnel. Mixture was stirred in carboys with a wooden broom handle. The siphon in the hose was started by filling it with water and a spring hand clamp was closed to keep the hose full when changing carboys. A special acid-burn first-aid kit was kept at hand but not used except for minor skin irritations. Also, 2000 lb of soda ash in 100-lb paper bags was stored near the pump.

Actual time schedule, acid-concentration and temperature figures are shown in Table II. After the soda-ash solution had been introduced and the boiler completely filled, the circulating-pump motor switch burned up during the restart. Neutralization was stopped and the boiler drained.

Heavy foaming occurred at the pump-supply tanks during cleaning and

neutralizing operations. It was allowed to overflow on the cement floor and continually washed away with fresh water.

The following day the boiler was opened and each individual tube washed with a fire hose. Inspection showed good metal cleaning but considerable after-corrosion caused by oxygen in the neutralizing solution.

Because considerable rust was formed on the metal by after-corrosion and because some of the deep pits contained scale or paint, loosened but not removed, tubes were given a second turbining using dull cutters. Drums were wire brushed and the entire internal surface of tubes and drums were coated.

Painting Operation

A painter and a helper worked in the upper drums aided by a helper in the lower drum whose job was to stop the paint brush at the lower end of each tube and inspect the last several inches coated. The painter's helper in the upper drum shot a hand-gun full of paint into a tube and the painter immediately inserted the air-driven rotary paint brush, allowing it to travel to the lower end of the tube as quickly as possible and then pulling it back through the tube at a slightly slower rate. For the one coat, 41½ gallons were required for the tubes and 5½ gallons for the drums.

Hydrogen embrittlement of boiler steel can result from any cold working after acid cleaning. Hydrogen is released by the interaction of acid and metal and a part of this hydrogen permeates the steel. This condition persists as long as hydrogen is present in the steel and would cause fractures at points of high stress concentration if not removed.

For this reason the boiler was "boiled out" at atmospheric pressure for two days before the regular cold hydrostatic test was applied. No cold working, such as tube rolling, was permitted until the embrittlement was relieved by heating.

Little is known concerning the time and temperature required to relieve hydrogen embrittlement and the treatment selected was based on a conservative guess. Since no cold working of the boiler metal was required, except the moderate stress below the yield point imposed by the hydrostatic test, it was considered entirely safe to return the boiler to service directly following the boiling out period and hydrostatic test.

TABLE II

Time

1:00 AM — Boiler filled with hot deaerated feedwater and allowed to cool somewhat.

8:00 AM — Circulating-pump system tested. Changes in position of some overflow hoses required.

10:00 AM — Circulating pump running. Acid added at pump suction, with four men each handling one suction hose.

		Temperatures			
Time	*% HCl In Solution By Test*	*Upper Middle Drum*	*North End Mud Drum*	*Lower Header W Waterwall*	*Lower Header N Waterwall*
10:00 AM	0.0	150	....	120	120
10:10	0.8	....	....	....	....
10:20	2.5	150	110	120	120
10:40	2.05	Acid addition completed			
11:00	1.4	....	....	....	....
11:20	1.38	149	112	118	118
12:45 PM	0.8	139	120	120	120
1:45	0.72	128	120	125	125
2:20	0.68	Pump stopped. Drain started			
5:00	Drain completed. Refilled with cold water and 1200 lb soda ash				
5:15	0.66% soda ash in solution				
5:17	0.65				
7:00	0.58	Temp in lower header, West waterwall 118 F			

Exhaust Lines

By L N ROWLEY

It sounds as if it should come from Scotland, but comes from the London School of Hygiene: Dr G P Crowden papered an entire room with highly reflective aluminum foil, and found that a single electric lamp would keep the room warm. The foil threw back the heat from the lamp so efficiently that no other heat was required through the entire winter. Before some of our "economical" friends snatch at the idea we ought to point out that nobody says anything about the size of the bulb or the size and location of the room. Anyway, the wife might prefer pink wallpaper.

Our friends on POWERFAX say "A pat on the back develops character . . . perhaps it does if administered low enough and young enough."

When it was built in 1892 (and until 1910), the Masonic Temple in Chicago was the highest and largest business building in the world. Called the Capitol Building in recent years, it was torn down this spring to make way for Chicago's new subway. Dealers who bought wrought-iron pipe from the wreckers got a pleasant surprise; after more than 46 years of service it was still good enough to sell second hand for many years of service in the future.

The condenser tailpipe makes a handy ejector when you need a little vacuum around the plant.

H W Hodgson, long-time POWER reader, writes the following—"Some years ago, while at a hydro plant, there was an interruption on the 70,000-volt transmission line. After the trouble had cleared, I glanced over the operator's shoulder at the log report. It read, "Amps went up, Volts went down and the Powder Factory went out of sight". The amps and volts part was easy, but it took a second or two to realize that "powder factory" wasn't so far from power factor. In spite of his imaginative but somewhat inaccurate translation of PF, that operator was one of the best I ever met."

Scientists now make films of molecular thickness (about one ten-millionth of an inch). Even a scientist can't see anything so thin, but they can tell a lot about them by listening to electrical charges on the film.

Bill Judge, of Willowbrook Dairy, told me how dry ice got him out of a literal jam. When a diesel piston froze, they tried the usual remedies, without much luck; the set-up just wasn't right for heating. Somebody thought of the dry ice used for packing some of the dairy products. Packed on top of a diesel piston, it did a fast, smooth job of "unfreezing" and the piston was released without any further trouble. Since then Bill has tried dry ice for other shrinking jobs and begin to think it's a mighty handy tool.

A European direct expansion ammonia unit, turning out small cylindrical blocks of ice, weighs so little that portable outfits have been found practical. Instead of cutting a 10-cent hunk for you, the modern iceman may make it before your eyes.

Modern Refrigerating Equipment Boosts Brewery Efficiency

New compressors and accessories, improved layout bring refrigeration system at Jacob Ruppert in line with best practice. Features include "desuperheaters" for high-pressure ammonia, double piping system with bypasses, and accumulators of new design

MODERNIZATION of refrigeration facilities forms a major part of the Jacob Ruppert Brewery program for putting power services on a highly efficient basis. To secure the best heat balance, design of power generating and refrigerating plants was closely coordinated and the same careful attention to engineering and operating details went into both. An article in July, 1939, POWER described the new boiler and turbine-generator plant; this outlines the features of the recently completed refrigerating plant.

Three-Pipe Ammonia System

As in any large brewery, refrigeration plays a part in nearly every step in brewing and must be furnished unfailingly to all parts of the plant. At Ruppert's, this means a 3-pipe ammonia distribution system that covers 3 city blocks horizontally, and in some parts of the plant rises 11 stories vertically. Every piece of refrigeration-using equipment is served by three lines: high-pressure liquid supply, low-pressure vapor return, and a pump-out line. Fig. 2 shows the general layout of the system.

Old compressors were all engine-driven angle-type. Modern high-speed vertical York units replace all but one of these machines; a 500-ton compound steam-engine-driven open-column duplex compressor remains in service to handle summer peak loads. Four of the new machines are 260-ton, 4-cyl, 14 x 13½ in., fully enclosed, pressure lubricated compressors direct connected to 400-hp, 225-rpm synchronous motors. Partial-cylinder bypass valves on the No. 1 unit give capacity control in 4 steps down to 50% load.

The fifth new compressor (No. 6) is likewise a vertical unit, with 4 cylinders, 11 x 13 in. A Westinghouse steam turbine in the basement drives it through a multiple V-belt. This turbine takes steam from the 120-lb header and can exhaust into either the 30-lb or 10-lb systems. In normal operation, turbine exhaust balances demand for 10-lb steam (used for brewhouse hot-water heating and for 1st-stage feed-water heating). Pressure in the 10-lb system controls the turbine throttle, so that speed and output of the compressor are regulated in accordance with demand for 10-lb steam. When turbine speed reaches rated maximum, a speed governor takes over, and any further 10-lb steam needs are handled by reducing valve from the 30-lb system.

The remaining 500-ton engine-driven York compressor was installed in 1907; it is being thoroughly reconditioned and will serve efficiently for many more years. Originally designed to take 120-lb steam (the old boiler pressure), this unit now gets steam from the 120-lb system, supplied from turbine extraction points. Temperatures will run up to 470 F depending on turbine load, well above the old temperature of about 350 F. Engineers expect no difficulties on this score, however.

These 6 compressor units give unusual operating flexibility and ability to match varying steam and power conditions. Normally, most of the load is carried on the motor-driven units, with operation of the turbine-driven machine depending entirely on demand for 10-lb steam. The 500-ton unit adds needed refrigeration capacity in the summer months, helps indirectly by increasing demand for 120-lb steam in relation

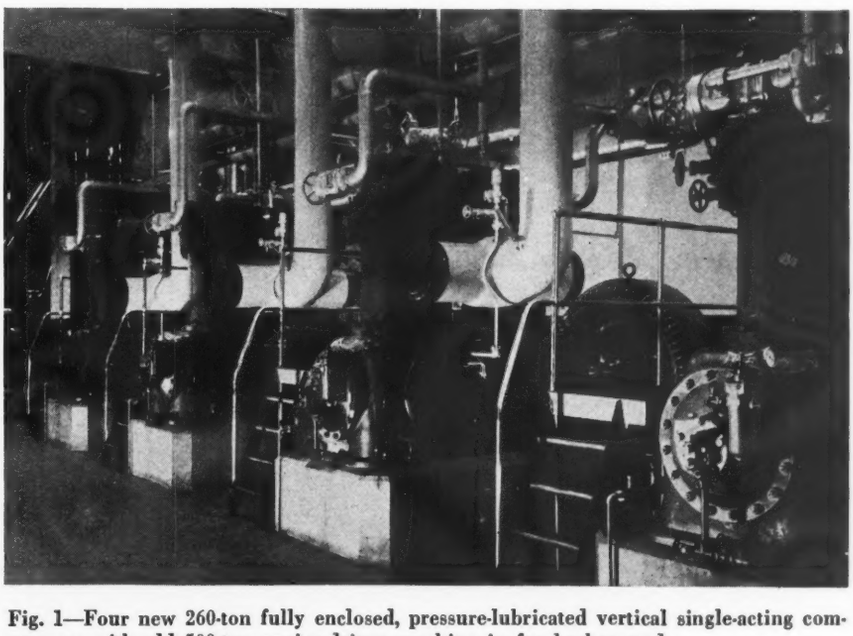


Fig. 1—Four new 260-ton fully enclosed, pressure-lubricated vertical single-acting compressors with old 500-ton engine-driven machine in far background

to electric load, and, because of ease of control by speed variation, it contributes to holding constant suction pressure. The turbine-driven unit, because of similar ease of control, makes an ideal pump-out machine.

Economies result from the operation of an ice plant; the 500-ton machine plays an important part in this connection. Ice commands a good enough price to make it worth while to maintain the tanks and handling equipment and to cover the cost of labor required for harvesting the ice. While peak demand for ice comes in the summer, when the brewery refrigeration load is heaviest, it represents load that can be sandwiched into low spots in the curve, or cut off if demand threatens to exceed capacity. The 500-ton machine operates condensing and the condensate goes to the ice plant for filtering and removing impurities, preparatory to use in making distilled-water ice.

High-pressure gas from the compressors goes first to "desuperheaters" where it is cooled to saturation temperature by raw makeup water on its way to the boilers. This arrangement accomplishes three things: (1) it recovers useful heat and decreases cooling-tower load, (2) effective separation of oil and refrigerant occurs during the chilling operation, and (3) by reducing the temperature range between hot gas and cold water in condensers, it contributes to longer tube life. Desuperheater tube life is relatively short, but units are designed for simple and cheap tube replacement.

Double Piping System

Fig. 2 shows the double piping system, with bypasses running from the compressor discharge headers through to the receivers. This gives complete interchangeability, permitting almost any piece of equipment to be operated in conjunction with any other. The 8 vertical single-pass condensers are arranged in two banks and the 6 liquid receivers are likewise connected in two groups. Each receiver group is fitted with an automatic purger for continuous removal of non-condensible gases.

Cooling water for refrigerant condensers and for steam condensers on the new turbines and the old engine-driven compressor comes from a 13,000-gpm forced-draft cooling tower on the roof. This unit, one of the largest ever made for a brewery, consists of six cells for ammonia condensing, each rated for 220 tons of refrigeration, and five cells for steam condensing.

Gains in the operating cycle result from heat interchange between high-pressure liquid going out into the distribution system and liquid carryover in the suction gas coming back. Liquid passes through coils in four accumulators, see Fig. 2. A small part of the liquid expands into the accumulator shell, under control of a float valve, to maintain a fixed level, making up for any deficiency of liquid carryover in suction vapor needed for high-pressure liquid pre-cooling. In most of the accumulators suction gas enters near the top, through a downward bend, and passes out by a separate outlet. The new 30-lb accumulator and the new horizontal accumulator for ale- and ice-plant suction are arranged so the suction gas bubbles up through the liquid.

The action of the accumulator-liquid cooler serves: (1) to remove any superheat from the suction gas, thus permitting the compressors to handle their maximum capacity in lb per min, (2) to subcool the liquid going to the evaporators, thus increasing refrigerating effect, and (3) to prevent liquid from reaching the compressor. The new accumulators, arranged for bubbling the gas through the liquid, are particularly effective in removing slugs of liquid and desuperheating the vapor.

Liquid ammonia flows out over a distribution system covering 3 city blocks. The biggest part of the refrigeration effect goes into chilling water (to about 34 F) for wort cooling. Chilling takes place in two Frick zigzag water coolers, each of 450 tons capacity maximum. In these units, liquid ammonia enters at the bottom of a zigzag coil, flowing upward. Water flows down over the coils in a series of cascades, directed by pans under each row of coils. A float control maintains a liquid level in a surge drum above the coils.

The next largest refrigeration load comes from the ice plant, which has a capacity of 250 tons of ice per day. This equipment dates back to about 1900, and so cannot be said to represent best modern practice. Direct-expansion coils, between rows of cans, cool the ice-field brine and the water in the ice cans; hand valves control expansion. When it becomes economically desirable, this equipment will be modernized, particularly with respect to can-filling and can-pulling arrangements, so that one man can handle harvesting at a much higher rate.

Beer Cooling and Storage

After fermentation, beer is cooled down to storage temperature (33 F) in double-pipe coolers, under control of a hand expansion valve. To meet the requirements of the different substances inside and outside the inner pipe, it is made of steel with a rolled-in copper-tube lining.

Another part of the refrigerating effect goes to keep beer-storage cellars cool. Beer comes into the storage tanks at the right temperature, so only heat leakage must be overcome by the refrigerating coils above the tanks. A unique arrangement in the Ruppert cellars overcomes frosting and other operating difficulties arising out of the constant floor washing required for cleanliness. In a typical cellar room, tanks are arranged horizontally, close together, from one side of the room to

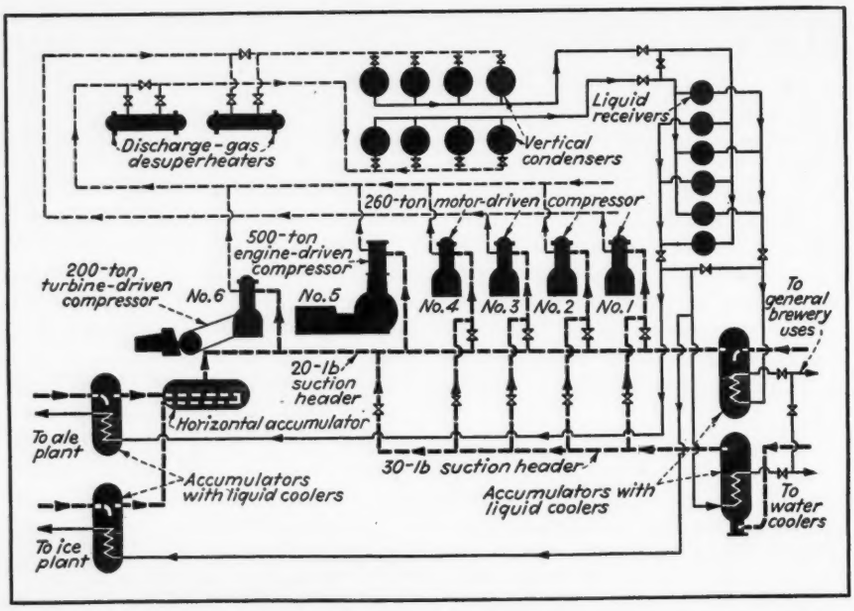


Fig. 2—Schematic piping diagram shows how double-header system, with numerous bypasses, gives operating flexibility and reliability

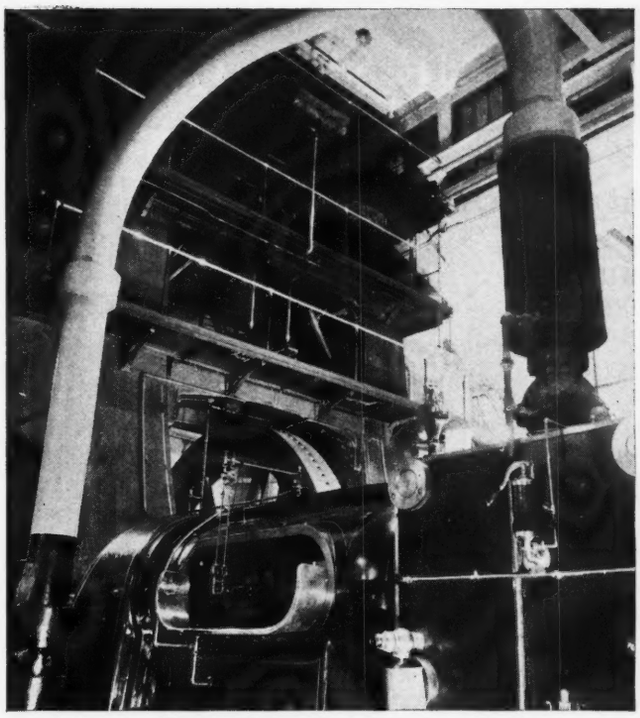


Fig. 3—When reconditioned, this giant 500-ton engine-driven unit will handle summer peaks efficiently

Fig. 4—Engine-room panel board mounts indicating gages and recorders for suction and discharge pressures

the other. At Rupperts, a partition runs across the width of the room, just back of the tank heads. This puts the tank heads, with valves and controls, on one side, and the main body of the tanks on the other. Expansion coils are in the latter section, which is kept dry. All operation takes place in the front end, which is washed down regularly. This side of the partition is cooled by a supply of chilled air from an air washer.

Other refrigeration uses include attemperator coils in fermentation tanks (supplied by water chilled in Baudelot coils), direct-expansion coils for hop cooling, miscellaneous air-cooling and up-to-date air-conditioning systems in conference rooms and restaurant facilities. In two buildings, water is cooled for air washing, cooling and purifying.

The Ruppert plant operates with two suction pressures, 20 and 30 lb. Since the lowest temperature required in a brewery is 32 F, with the exception of icemaking, there is no apparent need for suction pressures lower than 30 lb. However, in plants that have grown up over a period of years there is bound to be some equipment that is inefficient enough to require a lower pressure. Furthermore, where the plant covers a large area, pressure drop in piping to remote points will have to be overcome by lower suction pressure. In the face of these conditions, the most economical solution lies in two suction pressures.

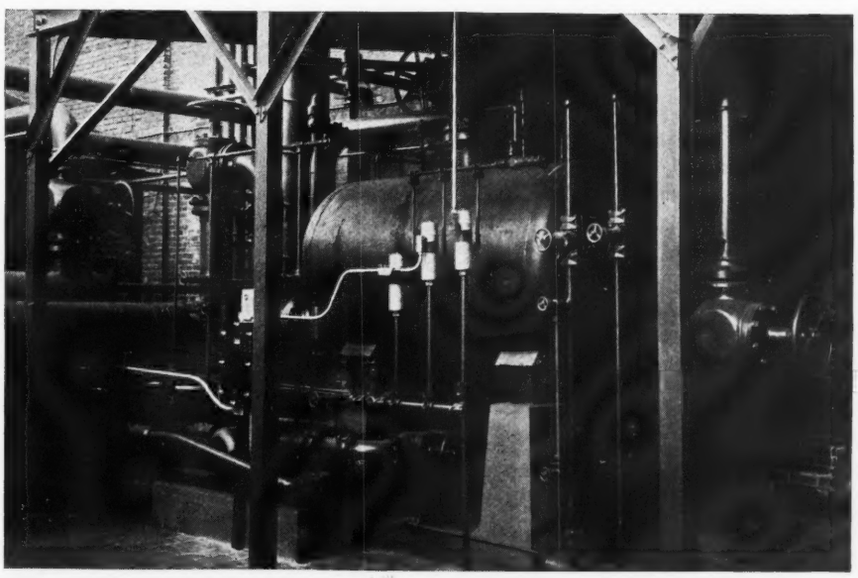


Fig. 5—Horizontal accumulator, for combined ale- and ice-plant suctions, installed on roof. Automatically controlled liquid pump is fitted wih high-level alarm

Suction Header Layout

The diagram shows the layout of the suction headers, with the biggest load, water cooling, carried at 30 lb. Suction from general brewery equipment comes into a 20-lb accumulator at one end of the header; suction from the ale plant and the ice plant comes into the same header at the other end. Each suction main ties to the header through its own accumulator. To improve conditions with respect to liquid slopover, an additional horizontal accumulator was installed. Accumulators protecting suction mains each have automatically controlled liquid pumps to handle excess liquid from accumulator to high-pressure liquid line. Automatic alarm systems sound warnings in the engine room if liquid level rises above normal for any reason.

Basic engineering behind the modernization of the refrigeration system was carried out in the Ruppert organization under the direction of Mr E Muhlhauser, general superintendent and brewmaster, Mr Wm Schuler, plant engineer, Mr Charles Arians, chief operating engineer, and Mr Henry Lieb, chief electrician.

LETTERS FROM A TURBINE SPECIALIST

No. 6—On Station Performance

By F S KOHL and
E L AUYER
General Electric Co, Lynn, Mass.

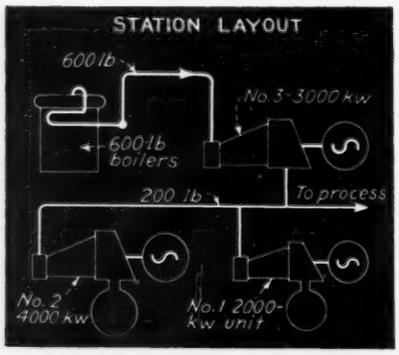
Dear Mr Specialist:

Our new superposed turbine went on the line a couple of weeks ago. Everything is working out beautifully, with one minor exception. We haven't, as yet, acquired that "sixth sense" of being able to estimate quickly the effect of flow and load changes.

For example, this morning we were running along with 6100 kw station load and 70,000 lb per hr going to process. In the course of a few moments our process demand dropped to 10,000 lb per hr. The station load remained the same. As the flow through the superposed unit (No. 3) decreased, its load, of course, also decreased. The 4000-kw unit (No. 2), which was the only condensing set on the line at the time, took over the transfer in load. With the new condition, we ended up with about 1400 kw on No. 3 and about 4700 kw on No. 2. This was an overload of 700 kw. We hurried around and got the 2000 kw unit (No. 1) on the line and took over this extra load. No damage was done, but had we known in advance the effect of this change in process flow, we could have had No. 1 already on the line. We had a pretty good idea that the flow change was coming.

What I would like to get is some chart or curve showing the over-all performance of the station. With such a chart we could tell at a glance the effect of expected changes and could operate the station accordingly. Is there an easy way of expressing this performance? I'll appreciate your suggestions.

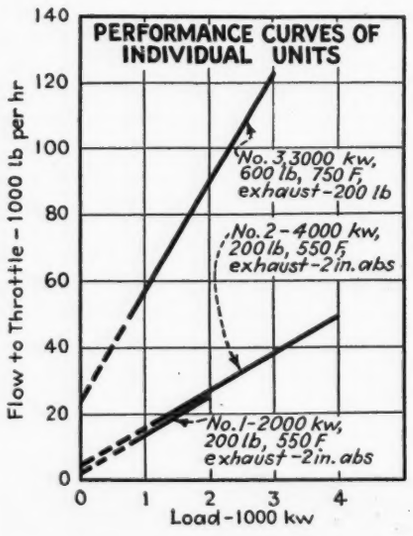
Very truly yours,
Engineer



Dear Mr Engineer:

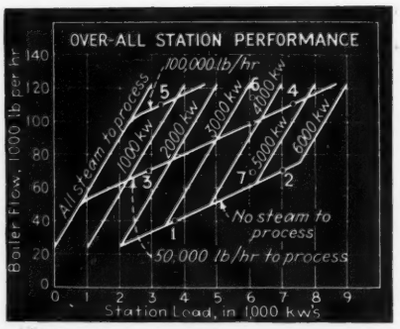
Your question on over-all performance is a good one. Such a curve can contribute a great deal to the intelligent operation of a station.

To get at this performance, lets consider your three units as a single machine—a condensing single automatic-extraction one. No. 3 serves as the head end; Nos. 1 and 2 as the exhaust end. Process steam coming from the exhaust of No. 3 is the "extraction." Because of this similarity, we can use


PERFORMANCE CURVES OF INDIVIDUAL UNITS
Flow to Throttle - 1000 lb per hr
Load - 1000 kw
No. 3, 3000 kw, 600 lb, 750 F, exhaust - 200 lb
No. 2 - 4000 kw, 200 lb, 550 F, exhaust - 2 in. abs
No. 1 - 2000 kw, 200 lb, 550 F exhaust - 2 in. abs

the extraction type of curve as a basis for yours. Station loads with assumed quantities of constant process or "extraction" flow can be plotted against boiler flow.

By taking the performance curves for the individual units (above), we can arrive at an approximate over-all station-performance curve. Points in table, referred to on the curve, were



used in plotting. Lines of constant process flow were drawn through them.

The curve derived by this method is not strictly correct as variations in initial temperature for units Nos. 1 and 2 have been neglected. Actually, this temperature varies with the load on No. 3. It could be taken into account but the error introduced is small.

The line labelled "All steam to process" is merely a replotting of the performance of No. 3. It assumes no flow is going to condenser. Reading on this line for a given boiler flow gives you No. 3's load directly, regardless of the condensing load.

Now, to help you in knowing how to operate Nos. 1 and 2, let's put lines of constant condensing load on the chart. When there is 1000 kw of condensing load we draw a line parallel to the line for No. 3 and 1000 kw to the right. Similarly parallel lines for 2000 kw, 3000 kw, 4000 kw, 5000 kw, and 6000 kw of condensing load may be drawn. Now if we recall your original example and locate point 6 to represent 6100 kw and 70,000 lb per hr to process, you can readily see why a drop to 10,000 lb per hr of process steam at point 7 required more than 4000 kw of condensing load so that you had to start up No. 1 unit.

Sincerely yours,
Turbine Specialist

Point	*Assumed boiler flow*	*Assumed process flow*	*Condensing flow*	*Load on No. 3*	*Condensing load*	*Station load*
1	40,000	0	40,000	490	3210 (No. 2)	3700
2	70,000	0	70,000	1400	5610 (Nos. 1&2)	7010
3	70,000	50,000	20,000	1400	1510 (No. 1)	2910
4	110,000	50,000	60,000	2610	4750 (Nos. 1&2)	7360
5	110,000	100,000	10,000	2610	670 (No. 1)	3280

Powered by DC

BY F A ANNETT
Associate Editor

Man has explored electricity for 25 centuries, yet it was only 109 years ago that Michael Faraday laid the foundation of modern electric power generation and application. For 2400 years before him, from the Greek philosopher Thalis (600 BC), countless curious-minded pioneers had delved into the mysteries of electricity and magnetism without finding the key that would unlock the door to our "electrical era."

Electrical science really got going around the beginning of the 19th century, when Galvani's experiments with kicking frog's legs led Volta, another Italian, to stack disks of copper, zinc and acid-damp cloth to make his "voltaic pile"—first source of continuous current. Oersted was the first man to connect electricity with magnetism. Experimenting with batteries, in 1819, he discovered that every conductor carrying an electric current is encircled by a magnetic field. Next, Davy, Arogo and others applied Oersted's discovery to magnetizing of iron and steel. Thus was born the electromagnet, an essential part of every generator and motor.

Then came Michael Faraday, the greatest of them all, with his pass key to all modern electrodynamic machinery. We have millions of dollars invested in generators today, only because this genius discovered electromagnetic induction—the fact that a conductor moving through a magnetic field generates a voltage.

Using Faraday's discovery, numerous inventors devised other generators, but it was not until about 1866 that commercial machines were developed by Gramme, Siemens and others.

Everybody knows today that every electric generator can be run as a motor, and every motor as a generator, but this fact remained hidden until 1873, when it was found that a Gramme dynamo, supplied with direct current, would operate as a motor. With these findings in hand, everything was ready for the rapid practical development of power generation, transmission and application, by Edison and hundreds of others.

They proceeded to build dynamos and motors in many forms, but all with two-pole horseshoe electromagnetic fields. Armatures, in those early days of practical electricity, were solid smooth cores with the winding on their outer surface. These structural features placed an upper limit on machine capacity, later removed by the development of the slotted-type armature core and the ring field frame, with its inward projecting poles. Technical historians have underestimated the importance of these two developments. It is true that Faraday's discovery made possible electric power generation, but the ring field frame and slotted armature core cleared the way for our modern structural design of generators and motors.

Sparkless commutation, characteristic of modern direct-current machines, was a hard-won engineering victory. Two things were necessary: Better brushes and a neutral brush position that would "stay put." Substituting carbon and graphite brushes for copper solved the first problem. The second was licked by an American, Milton E Thompson, who invented commutating poles and applied them in 1893 to commercial machines, in combination with a poleface compensating winding.

With these problems solved, motor applications advanced rapidly until today the direct-current motor is the most versatile power unit ever developed. No other type of motor will handle such a wide range of exacting requirements. That is why direct-current motors still find extensive application, despite the wide use of alternating current for power generation and transmission.

Because of the importance of direct-current motors in the power field, we present here a concise practical guide to assist engineers in their everyday problems. This, POWER's 29th special section, explains how direct-current motors operate, describes the different types, shows how to select, connect and reverse—how to maintain and stop troubles. All this within 16 pages that can be read in a couple of hours. A similar 16-page section on alternating-current motors will follow in April POWER.

Fundamentals

► AN UNDERSTANDING of electric motors, both direct-current (dc) and alternating-current (ac), is based on a few simple fundamentals. With these in mind, we will all speak the same language.

There are two types of magnets: permanent and electro; both have the same properties and act the same under identical conditions. Permanent magnets are made of tempered steel, which, once magnetized, retain their magnetism. Any magnet is surrounded by a field of force represented by lines, Fig. 1, coming from the north (*N*) pole and going around to the south (*S*) pole.

Like magnetic poles repel, that is, when the south poles of two magnets are brought near each other, Fig. 2, they fight each other off just like two fans blowing toward each other do. Unlike poles attract, the field of one magnet joining that of the other and surrounding the two magnets, Fig. 3.

Magnetic Field

An electric current flowing through a conductor produces a magnetic field that rotates about it as in Figs. 4 and 5. In Fig. 4, + on the end of the conductor represents current flowing away from the reader. In this direction, the current produces a clockwise magnetic-field rotation. The dot on the end of the conductor, Fig. 5, represents current flowing toward the reader and the magnet field rotates counter-clockwise.

The same laws that apply to fields of permanent magnets govern the field around a conductor carrying an electric current. If you bring two conductors, Figs. 4 and 5, together as in Fig. 6, their fields oppose each other and tend to force the conductors apart. Currents flowing in the same direction in two parallel conductors set up opposing fields between them. The magnetic fields combine to surround the two, Fig. 7, and tend to pull the conductors together.

Fig. 7 illustrates the principle of an electromagnet, Fig. 8, which shows the cross section of a coil of 4 turns. The strength of a magnet is proportional to to the number of turns in the coil multiplied by the current in amperes flowing through them. This product is called ampere-turns. Putting an iron core in the coil increases the strength of its magnetic field many times. This is one important reason for using iron in the magnet circuits of all electric machines.

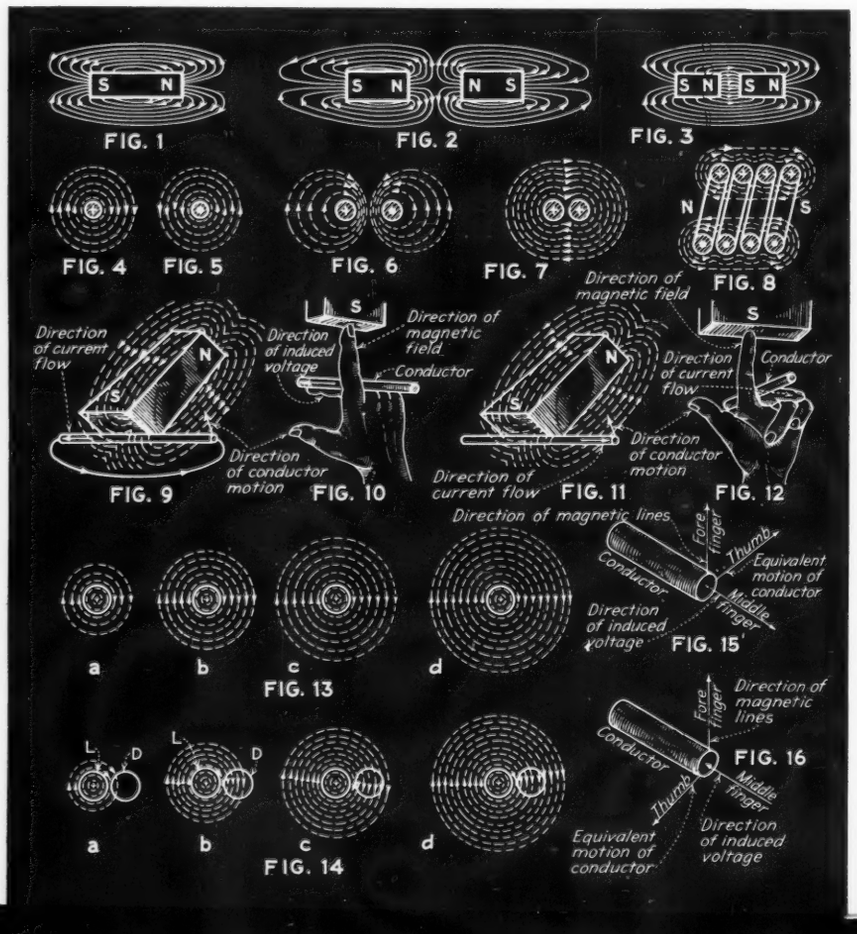
Electric Generator

A conductor placed in a magnetic field, as in Fig. 9, and moved to cut across it generates a voltage. This is the simple principle of an electric generator. To determine the direction of voltage generated in the conductor, place the thumb and first two fingers of the right hand at right angles to each other, Fig. 10. When the forefinger points in the direction of the lines of force and the thumb in the direction that the conductor moves, the middle finger indicates direction of voltage. If we connect the conductor ends together, a current will flow in the direction indicated by the arrows. Reversing either direction of the conductor's motion or of the magnetic field, but *not both*, reverses direction of the voltage generated.

By applying the principle of the generator we can explain many other things about electric circuits and equipment. In Figs. 13*a*, *b*, *c* and *d* are shown the successive steps in development of a magnetic field as current increases in a conductor. When the current decreases in value, the reverse effect occurs, that is, the circular magnetic lines contract into the center of the conductor, as shown by *d*, *c*, *b*, *a*. Now, as these circular lines expand out across the conductor or contract into its center they are cut by the conductor, just as if the field were stationary and the conductor moved. Consequently, a voltage is generated in the conductor. This voltage is said to be produced by self inductance and is in a direction that opposes any change in the current. If the current increases, the induced voltage opposes the applied voltage. A decreasing current produces a voltage that tends to keep the current flowing.

Induced Voltage

If a dead conductor *D* is near a conductor *L* carrying a current, as in Figs. 14*a*, *b*, *c* and *d*, it will have a voltage induced in it if the current in the live conductor changes its value. The voltage induced in the dead conductor is said to be produced by mutual induc-



Figs. 1 to 3—Permanent magnets and fields. Figs. 4 to 7—Magnetic fields about conductors carrying electric current. Fig. 8—Cross section of an electromagnet. Fig. 9—Fundamental principle of an electric generator. Fig. 10—Right-hand rule for generated voltage. Fig. 11—Fundamental principle of an electric motor. Fig. 12—Left-hand rule for direction of motor rotation. Fig. 13—How a magnetic field expands and contracts about a conductor as current increases and decreases. Fig. 14—Conductor *D* in the magnetic field of conductor *L*. Figs 15 and 16—Rule for determining direction of induced voltages

tance and is the principle of the induction coil and transformer.

With direct current, we get these effects only when the value of the current changes in the circuit, such as when a switch is closed or opened. As soon as the current reaches a constant value, there is no further change in the magnetic field, and the induced voltage ceases to exist. In an alternating-current circuit, an induced voltage is always present because the current is continually changing in value.

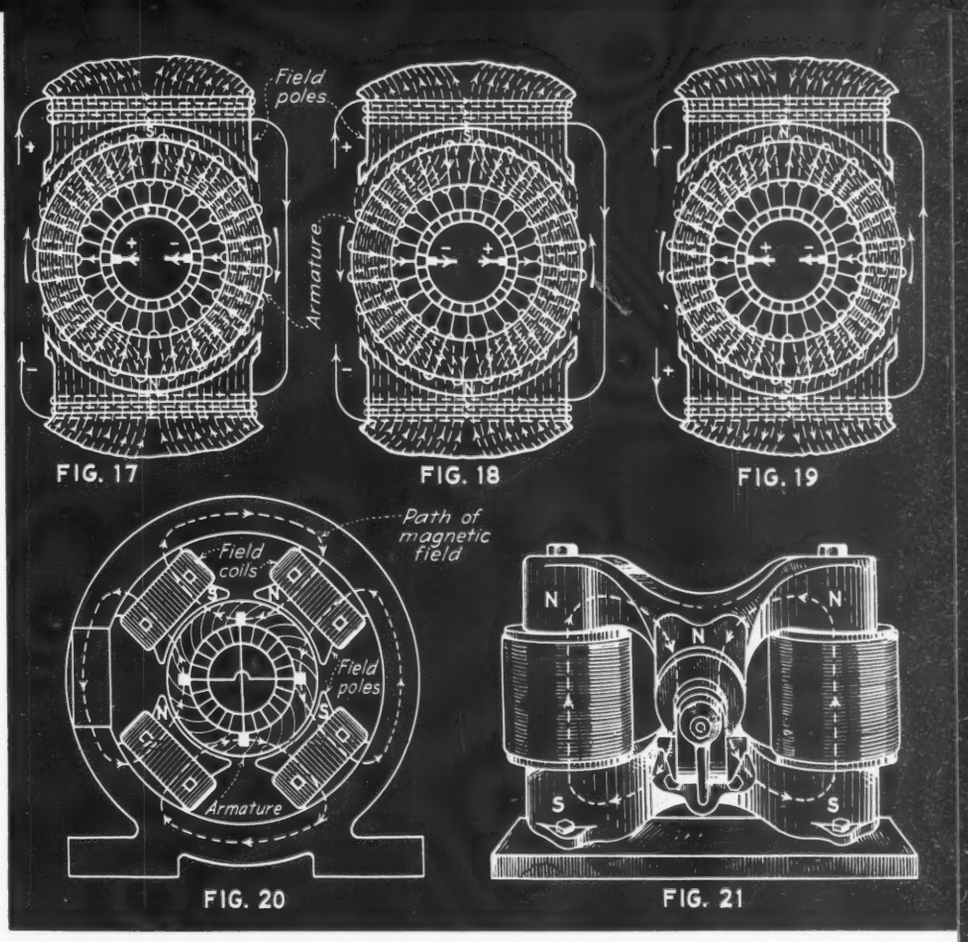
Voltage Direction

Figs. 15 and 16 show how to determine the direction of induced voltage. Consider the left-hand side of the conductor in Fig. 13*a*. As lines of magnetic force expand from the center of the conductor they move across the conductor from right to left. This produces the same effect as if the magnetic field were stationary and the conductor moved to the right. On the same side of the conductor, the direction of the magnetic lines is up. Then, if we place the thumb and forefinger of the right hand on the conductor to indicate direction of magnetic field and equivalent motion of the conductor, as in Fig. 15, the middle finger, indicating direction of induced voltage, points toward the reader. The induced voltage is therefore opposite to the direction of current flow, which is away from the reader.

Now, consider the left-hand side of the conductor, Fig. 13*d*, and assume that the lines of force are contracting because the current is decreasing in value. The lines of force will then be moving from left to right into the center of the conductor. This is equivalent to moving the conductor from right to left across the field, which is the opposite to the previous case. The lines of force are still upward. This relation is given in Fig. 16, in which the middle finger points in the same direction as the current flow. In other words the induced voltage tends to keep the current flowing. The effects obtained for the left-hand side of the conductor hold for any side and the rule may also be applied to direction of voltage induced in the dead conductor *D*, Fig. 14.

Electric Motor

A conductor carrying an electric current through a magnetic field, Fig. 11, tends to move at right angles to the field. The force thus produced is the principle of an electric motor. To determine the direction of the force acting on the conductor, place the thumb and first two fingers of the left hand at right angles to each other, Fig. 12.



Figs. 17 to 19—Diagrams of direct-current motors. Fig. 20—Salient-pole-type field frame for direct-current machines. Fig. 21—Consequent-pole field frame for dc machines

When the forefinger points magnetic-field direction and the middle finger direction of current, the thumb shows direction in which the conductor tends to move.

Fig. 17 is a diagram of a simple dc motor with a ring armature. The field poles are electromagnets and the armature an iron ring with a winding around it. Equidistant points in the winding connect to copper bars in a commutator on which brushes contact and connect to the power source. Practically all motors and generators have drum-type armatures with the winding distributed in slots on the outside of a soft-iron or steel core, but the ring-type armature is more simple for study. Behavior of a ring armature holds for the drum type.

Direction of Rotation

In Fig. 17, current is led into the armature winding at the + brush and out at the — brush. This gives a current direction away from the reader in the outside conductors on the top half of the armature and toward the reader on the bottom half. Applying the rule, Fig. 12, it will be found that the current in the top and bottom halves of the winding produce clockwise turning effort, indicated by the curved arrows. This turning effort is called torque. If we reverse the current in the armature, as in Fig. 18, the turning effort is reversed, as can be checked by applying the rule, Fig. 12. If we reverse field-pole polarity by reversing current direction in the coils, Fig. 19, we reverse armature rotation. If both field and armature currents are reversed, armature rotation will continue in the same direction.

Counter Voltage

When the armature of a motor starts to rotate, its conductors cut across the magnetic field and a voltage is generated. Applying the right-hand rule, Fig. 10, to the direction of rotation and lines of force, Fig. 17, we find that the voltage generated in the conductors opposes the current flow. Because the generated voltage (electromotive force) opposes the applied voltage it is called counter-voltage or counter-electromotive force.

Motors, according to their size and speed, are built with two poles (bipolar) and 4, 6 or more poles (multipolar). Modern motors are of the salient-pole type. Fig. 20. Some of the earlier types of motors had consequent poles, Fig. 21. In this design, the field coils are connected to produce opposing poles that combine into single poles at the armature, as shown. The many designs of modern motors will be considered later.

Motor Types

▶ LIKE CAESAR'S GAUL, direct-current motors are divided into three classes: *series, shunt* and *compound.* In all three the armature is practically the same; the essential difference is in the field frame and field-coil arrangement and how these coils are connected. Each of the designs may be further subdivided into *noncommutating-pole, commutating-pole* and *compensated* types.

The simplest of these is the series, Fig. 1, shown connected to a simple manual starter. Since the armature and field coils are connected in series, the latter must be wound with conductors large enough to carry the armature current without heavy losses.

Series Motors

In Fig. 1, the starting box arm is on the first starting point of the resistance to complete the circuit. This circuit is from the + side of the line through the starting resistance, the holding coil, field coils and armature to the — side of the line. Everything is in series so that there is but one circuit.

Because the resistance of dc-motor armatures is low they must be started with a series resistance, which is cut out of the circuit as the motor comes up to speed and generates a counter-electromotive force (mentioned in the previous article), to limit current in the armature circuit.

In a series motor, the field and armature windings are connected in series so that current decreases simultaneously in the armature and in the field coils. This means that the field strength goes down. Weakening the field requires that the armature run faster to generate a given counter-voltage. This is what happens in a series motor and, at no load, the motor races to destruction.

Increasing the load boosts the current in both armature and field coils. This raises field strength and tends to increase the counter-voltage at a time when the armature is slowing down to increase the load current. Consequently, the armature must slow down much more for a given load increase than if field strength were held constant. Thus, speed of a series motor varies over a wide range with changes in load, which for most loads is objectionable.

In Fig. 1, if the current is doubled in the armature it is also doubled in the field coils. Within certain limits, doubling the current in the field coils will double the strength of the field poles. Motor torque is proportional to the product of armature current and strength of the field poles. Then, if both of these are doubled, their product increases four fold instead of twice, the case if only the armature current is doubled.

This characteristic makes a series motor well suited where high starting torque is required and the speed of the motor is controlled by an attendant, such as on hoists and electric railways. Series motors in the smaller size are also used to drive constant loads, such as fans.

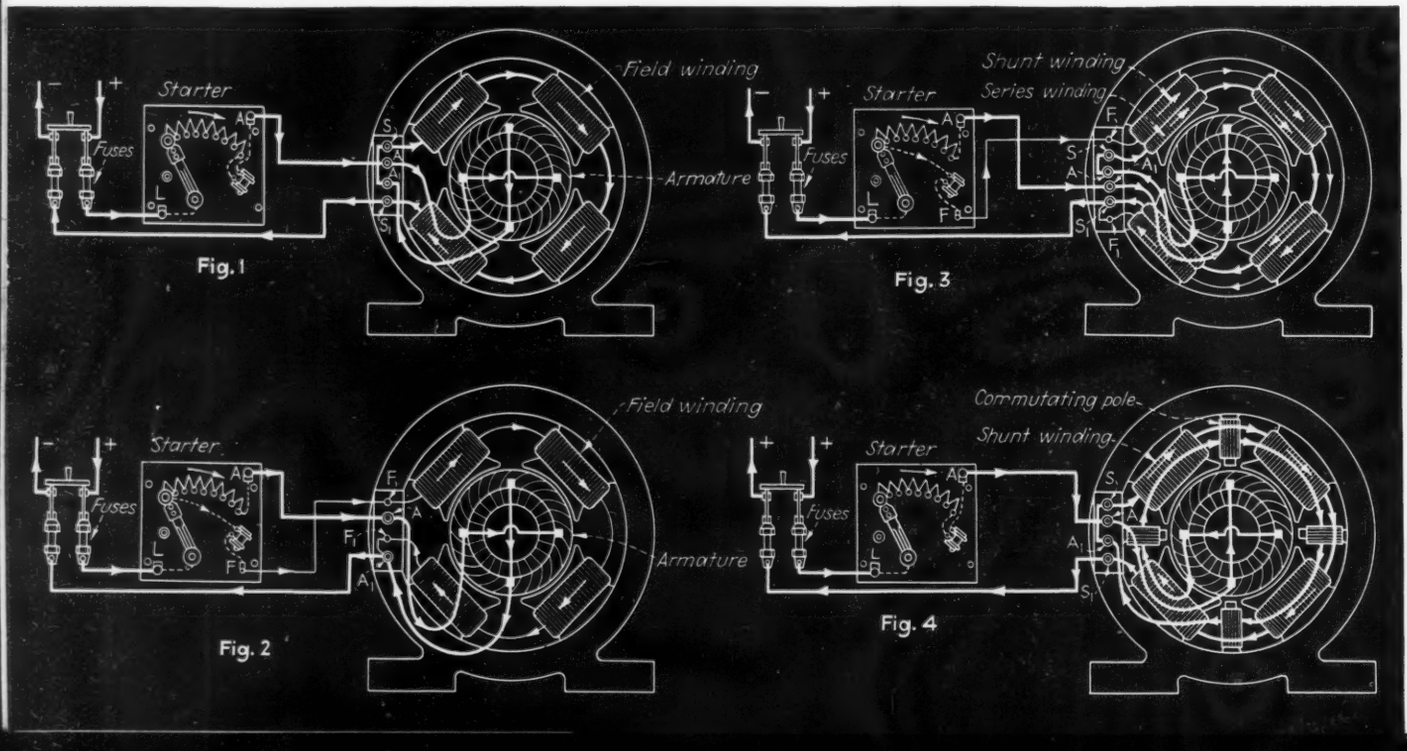
The simple shunt-type motor in general appearance is very much like the series motor. In fact, in the smaller sizes, it is somewhat difficult to distinguish one from the other. A shunt-type machine gets its name from having its field coils connected in parallel with the armature, or, as it is sometimes called, in shunt.

Shunt Motors

Fig. 2 shows a shunt motor connected to a simple manual starting box, with its contact arm on the first starting point. One motor circuit is from the + line through all the starting resistance, armature and to the — line. The other circuit is from the first point of starting resistance and field coils, then joins the armature lead and goes to the — line. Thus, the field coils are connected directly across the line and must be wound with a large number of turns of wire of comparatively small cross section, to keep the field current consistent with high efficiency.

In the larger-size motors of, say, 3 hp and up, series and shunt motors can be distinguished by the size of their field-coil leads. On a series motor, the field leads are of the same size as those from the armature, but on a shunt machine, the field leads are smaller than those from the armature, as indicated in Figs. 1 and 2. When tested on a circuit of the machine's rated voltage, a lamp connected in the field coils of a shunt machine will glow dimly, but on a series it will burn brightly.

Fig. 1—Series motor connected to manual starting box. Fig. 2—Shunt motor connected to manual starter. Fig. 3—Compound motor connected to manual starter. Fig. 4—Commutating-pole series motor connected to manual starter



Because the field coils are connected across the line, the current in them and the strength of the magnetic field will be practically constant. Therefore, the torque of a shunt motor varies directly as the current in the armature. That is, doubling the current through the armature doubles the torque of the motor.

The field strength of a shunt motor, being constant, makes its speed practically constant. A decrease in speed of less than 10% from no-load to full load will reduce the counter-voltage sufficiently to let full-load current flow through the armature. To sum up, two characteristics mark the shunt motor, a torque that varies directly as the armature current and a fairly constant speed. This behavior pattern makes this type of motor the most popular of the dc designs. It is suitable for a wide variety of drives where starting duty is not severe and where a fairly constant speed is required over a wide range of load.

Many drives need a fairly high starting torque and reasonably constant speed while running. These require a combination of series- and shunt-motor characteristics, obtained in what is called a compound-wound motor, Fig. 3. This motor has a shunt winding that is connected across the line as the shunt motor has in Fig. 2, and a series winding connected in series with the armature, as in Fig. 1. The same type of starting equipment used for the compound motor serves for the shunt type.

Because of the effect of the series winding, speed of a compound motor is not as constant with varying loads as the case on a shunt motor. Whereas speed of a normal shunt motor will vary less than 10% from no-load to full load, that of a normal compound motor will vary about 25%. This characteristic makes the compound motor well suited to flywheel applications such as punch presses, jaw crushers, reciprocating pump and similar drives. The shunt winding stabilizes the motor speed during light load periods. Then, when the heavy load comes on, because of the punching or crushing operation, the effects of the series winding causes the motor to slow down so that the flywheel gives up part of its energy to help carry the peak load. Where the series winding is required for starting only, the control may be arranged to cut it out of the circuit after the motor has been accelerated to nearly full speed.

Compound Connections

Normally, the series- and shunt-field coils of compound motors are connected so that they have the same polarity. The motor is then known as a cumulative compound. In some applications, where close speed regulation is required, the series and shunt windings are connected to have opposite polarity. Such a motor is known as a differential compound, a specially designed motor having a series winding of a number of turns that will vary the field strength just enough to hold speed constant with changing load. A standard compound motor will race if the series- and shunt-field windings oppose each other.

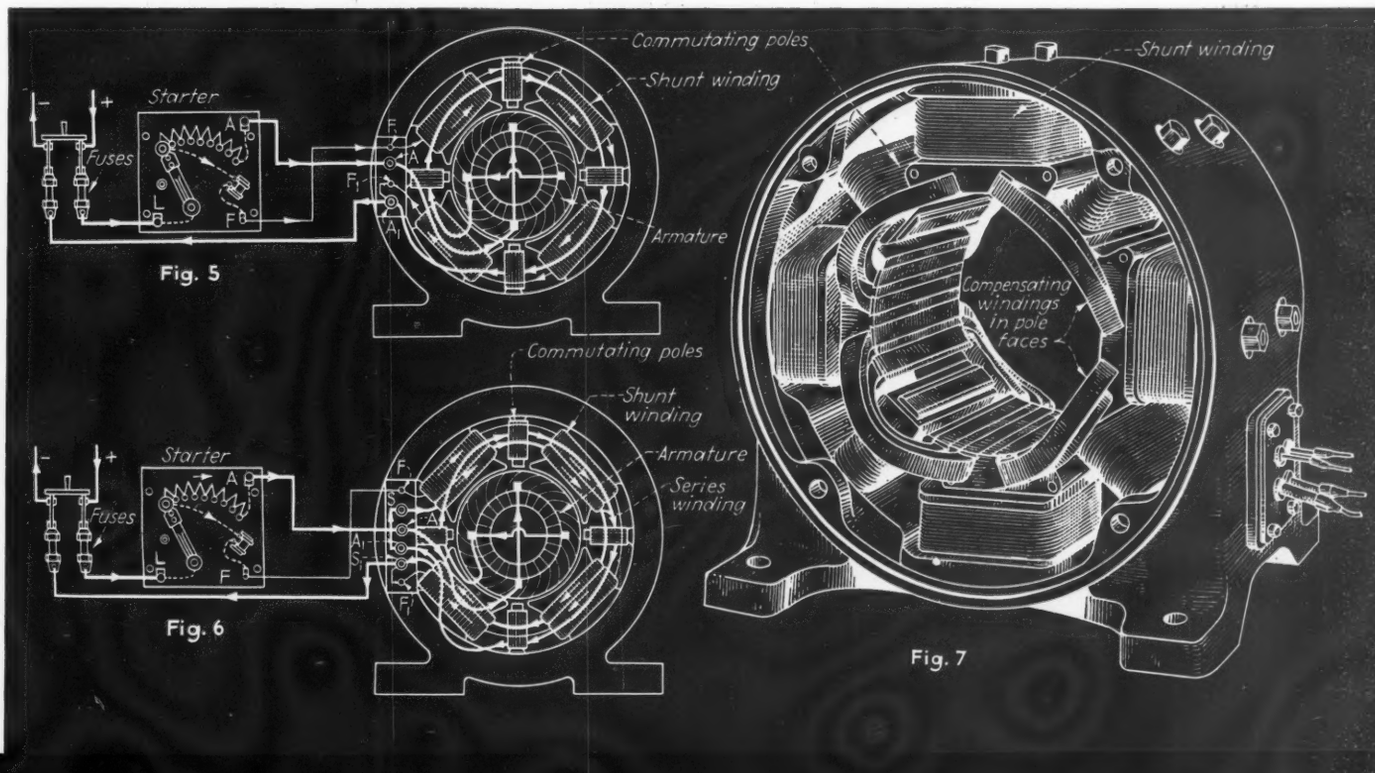
Most modern dc motors are equipped with commutating poles or, as they are sometimes called, interpoles. These are small poles between the main poles that hold the neutral points fixed on the armature so that sparkless operation can be obtained with brushes in a fixed position. (See article on page 84.) The coils on the commutating-poles are wound with conductors of comparatively large cross section and connected in series with the armature to give the poles the same polarity as the armature.

Fig. 4 shows a series commutating-pole motor connected to a manual starting box. This motor is the same as in Fig. 1, except for the windings on the commutating poles which are connected in series with the armature. The commutating-pole field coils are really part of the armature circuit and are generally connected directly in series with it, as in Fig. 4. Commutating-pole machines, then, have the same number of terminals as a machine without commutating poles, Fig. 1.

Fig. 5 shows a shunt commutating-pole motor connected to a manual starting box. Fig. 6 is a compound-wound motor of the same type. These motors are the same as the non-commutating-pole type, Figs. 2 and 3, except for the windings on the commutating poles which are connected in series with the armature. These machines also have the same number of terminals as motors, Figs. 2 and 3, with the same markings.

Commutating poles do not completely neutralize the effects of armature reaction, and for very severe applications motors with compensating windings are used. In addition to the commutating poles used in Figs. 4 to 6, the main pole faces are slotted and a winding put into them as in Fig. 7. This winding is of low resistance and is connected in series with the commutating-pole winding and the armature. Current in the compensating winding flows in an opposite direction to that in adjacent armature conductors.

Fig. 5—Commutating-pole shunt-motor connected to manual starter. Fig. 6—Commutating-pole compound motor connected to manual starter. Fig. 7—Field poles with pole-face windings of a commutating-pole, compensated-type motor



Connections

▶ WHEN MOTORS AND CONTROLS are installed, connections are usually made from simplified diagrams supplied by the control manufacturer. These diagrams apply to any motor of the same type, even though the armature and field terminals are not arranged the same on all makes of motors. The simplified diagrams are easy to use and it is not difficult to connect motors correctly if you observe a few rules.

Shunt Motor Hookup

Fig. 1 is a simplified diagram of the shunt commutating-pole motor, Fig. 2. The armature is represented by a circle, which is labeled as such and the field windings are shown by sawtooth lines. Sometimes field coils are represented as a spiral spring, Fig. 3, and resistance by a sawtooth line, Fig. 4. The standard symbol for a coil, however, is a sawtooth line, Fig. 4. The standard resistance symbol is as shown in Fig. 5. However represented, they are usually labeled on the diagram, as in Fig. 1.

Comparing Fig. 1 with Fig. 2, one can see that the connections are the same. *A* on the starter connects to *A* terminal on the motor only; *F* on the starter connects to the shunt-field terminal *F* on the motor. The commutating field terminal A_1 and shunt-field terminal F_1 connect together and go to the line. *A* terminal on the starting box could be connected to A_1 and *A* to F_1 and these two to the line as in Fig. 6. This reverses the direction of current through the armature and commutating-pole winding, changing direction of rotation.

In both Figs. 1 and 6, note that even though a single armature and field circuit connect to *A* and *F* terminals on the starter and that the other free armature and field terminals connected together and to the line, the commutating-pole winding is always treated as part of the armature circuit. In all cases where this winding is connected correctly to the armature the connection should not be disturbed.

A common mistake made in attempting to reverse a motor is to cross the line and armature wires as in Fig. 7. A motor connected this way will start but will run at an excessive speed before all the starting resistance is cut out of circuit.

A shunt motor can also be reversed by crossing the field connections, Fig. 8. It does not make any difference which is reversed, the current in the field or in the armature, as long as the connections are made correctly.

Connections of a compound motor are not necessarily more complicated than a shunt machine, if one considers the compound machine as a shunt-wound motor with a series-field winding on it. Fig. 9 is a simplified diagram of a commutating pole compound motor. All connections on this diagram can be identified on the more complete drawing of the motor in Fig. 10.

Following the armature circuit from *A* terminal on the starter through the armature, commutating-field winding and the series-field winding, we find that all are in series—the circuit is completed from S_1 to the line. This circuit, minus the series winding, is just the same as the armature circuit of the shunt motor, Fig. 1. The shunt-field circuit, Fig. 9, is from *F* on the starter through the field winding and to the — line. This is identical with the field circuit, Fig. 1. Series- and shunt-field windings, Figs. 9 and 10, are connected so that current flows through both in the same direction, indicating that both should have the same polarity.

Whereas a shunt motor may be reversed by changing the direction of the current in either the armature or the field coils, on a compound motor reversing is best done by crossing the armature leads only, as in Fig. 11. If the motor is reversed by changing the direction of the current in the field coils, then it must be reversed in both the series and shunt; this complicates the operation. Comparing Fig. 9 with Fig. 11, one can see that the only change made in the connections is that wires connecting to the *A* and A_1 terminals have been interchanged, leaving the series-field and shunt-field connections the same in both diagrams.

About the only time that most motors have to be reversed is when they are first put into service. If they do not have correct direction of rotation when started they must be reversed. For regular reversing service, such as on elevators, hoists, electric railways and other applications where reversals are frequent, a means of reversing the motor is built into the control equipment.

On some applications, reversals may be required infrequently. For example, at one period a fan may exhaust from a room and at other times discharge into it. For such jobs, a simple two-pole, double-throw switch connected as in Fig. 12 will do the trick. With the switch closed to the left, current flows up through the armature circuit; closed to the right, current flows down through the armature circuit. Fig. 13 is a similar connection for a shunt motor.

When a motor is first connected, we should make sure that the shunt-field circuit is complete and, if the motor is compound-wound, that the series- and shunt-field windings have the same polarity. These conditions can be determined by simple tests. After a shunt motor has been connected to the starter or controller and is ready for starting, disconnect the armature wire at the motor, close the line switch and place the starter on the first point. Open the switch slowly and if the field circuit is complete an arc will occur at the switch. Absence of a spark shows that the field circuit is not complete. The cause must be found and corrected. As long as the field circuit tests open, something is wrong and the motor will not start if the brushes are set on the neutral of the commutator. Even if the motor does start it will race.

Testing Compound Motors

The same test can be made on a compound motor. When the shunt-field circuit tests "complete" as previously explained, then cut out the series winding, as in Fig. 14, and try operating the motor on the shunt winding only. Note the direction of rotation. When the motor operates satisfactorily as a shunt machine, shut it down, open the shunt-field circuit and connect in the series winding, Fig. 15. Then, close the switch and try starting the motor on the series winding. On this test, just let the motor start so that the direction of rotation can be noted.

When direction of rotation is the same with either the shunt or series winding in circuit, then connect in the shunt winding and the motor is ready for operation. Should the direction of rotation not be correct, change it by reversing the direction of the current through the armature as previously explained.

Today most starters are full automatic or pushbutton types. These are built in a countless number of forms but the principles, laid down in the foregoing, hold for initial starting of a motor. Be sure that the connections are correct; if you have the least doubt, re-check them.

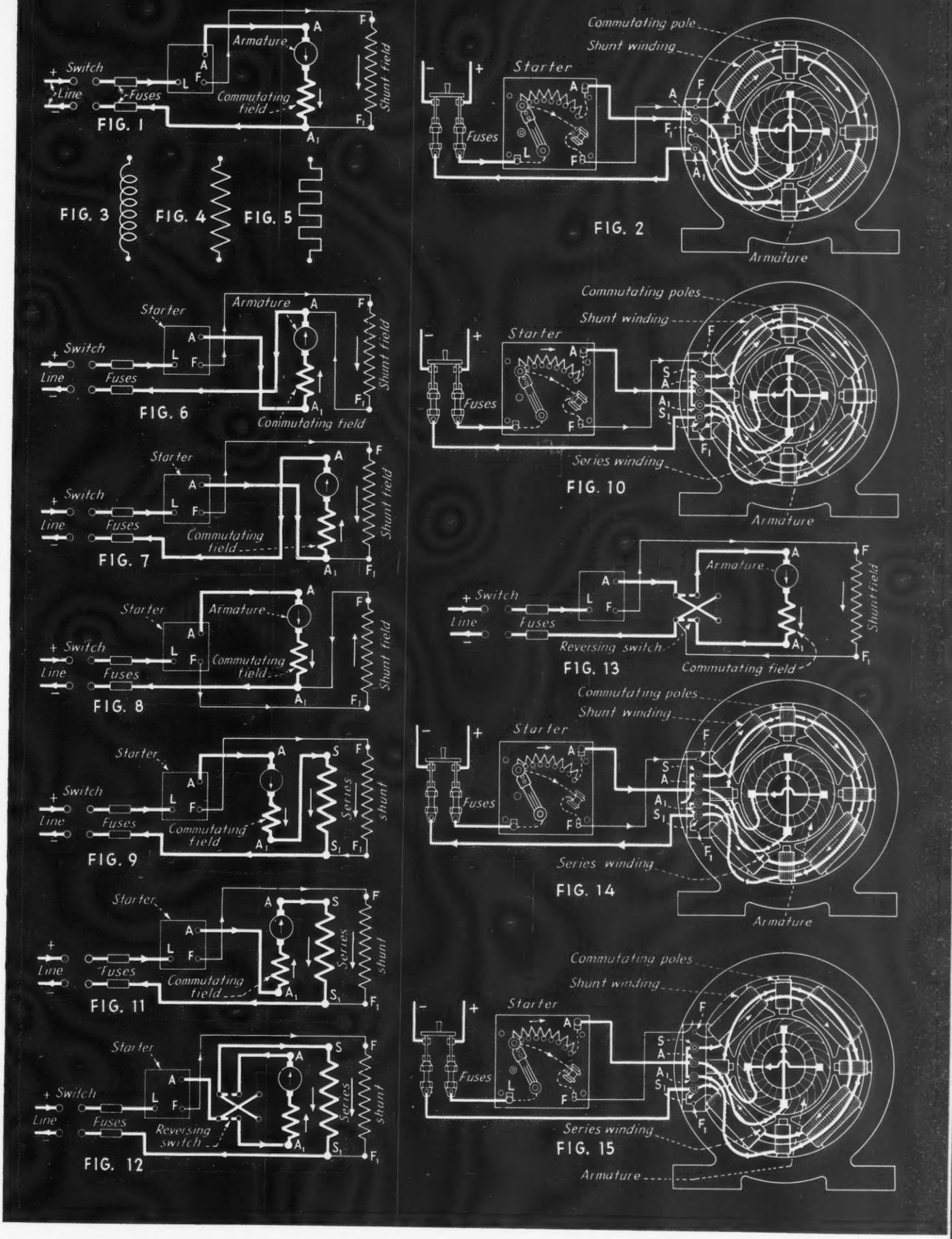


Fig. 1—Diagram of shunt motor and starter, Fig. 2. Figs. 3 and 4—Symbols for coils. Figs. 4 and 5—Symbols for resistance. Fig. 6—Same as Fig. 1, but current reversed in armature circuits. Fig. 7—Wrong connection for reversing shunt motor. Fig. 8—Same as Fig. 1, except current is reversed in shunt field coils. Fig. 9—Diagram of compound motor and starter, Fig. 10. Fig. 12—Reversing switch connected in armature circuit of compound motor. Fig. 13—Reversing switch connected in armature circuit of shunt motor. Fig. 14—Series winding cut out of compound motor to test polarity of shunt-field coils. Fig. 15—Shunt winding cut out of compound motor to test polarity of series coils.

How to Select

▶ DIRECT-CURRENT MOTORS of 200 hp rating and less for different services have been standardized to quite a high degree by the National Electrical Manufacturers Association (NEMA). These standards are a useful guide to the types available, their characteristics and what may be expected of them.

Table I gives standard ratings in horsepower and speed of open and semi-inclosed, continuous-duty, constant-speed motors. Horsepower ratings and speed in this table correspond to those for standard 60-cycle, alternating-current, squirrel-cage, general-purpose motors. Therefore, insofar as speed is concerned, both classes of motors are interchangeable. General-purpose motors, as listed in the table, are designed to be connected to loads by any of the standard means: gear, chain, belt or direct coupling.

Gearmotors

In ratings of 50 to 200 hp and speeds of 1750 and 1150 rpm, standard lines of motors are available for direct connection only. Where direct connection is necessary at other than standard motor speeds, gearmotors may be the best answer to the problem. These combine a motor and gear into a single unit that, with single-reduction gears, requires very little more space than a standard motor. Motors on these units operate at standard speeds, with a gear ratio to give any desired output speed.

Gearmotors are generally directly coupled to their loads, but they have been connected by belt or chain. When this is done, check with the motor manufacturer to make sure that the output-shaft bearing will stand the increased load imposed by the transmission equipment.

Adjustable-speed dc motors for speed ranges of 2 to 1, 3 to 1 and 4 to 1 are standard up to 50 hp ratings, for machine-tool service and similar applications. Standard adjustable-speed motors for a speed range of up to 6 to 1 are built for reversing planer service. For direct connection to fans, dc motors have been standardized in size up to 50 hp, for minimum speeds of from 94 to 380 rpm and 50 to 75% speed increase by field control.

Speed of a shunt-wound, constant-speed, continuous-duty motor should not vary more than 10% from full load to no load based on full-load speed, when the motor is operating at full-load temperature. Under similar conditions a 25% variation in speed is permitted with a general-purpose compound-wound motor. Speed of general-purpose shunt motors can be increased 25% by field control.

Direct-current motors are not only standardized according to their electrical characteristics but also for type of protective inclosure. These operate in all kinds of atmospheric conditions where dust, acid fumes and moisture may be present. These conditions must be kept in mind when selecting motors.

If satisfactory for the service, a general-purpose open-type motor should be used. This type has no ventilation restriction other than that made necessary by mechanical features. Consequently, it has the highest rating for a given frame size and the lowest cost per rated horsepower. In some locations, protecting screens are required over the end-shield openings to keep out small objects. Such motors are called semi-inclosed. These screens increase the cost of the motor about 7.5% and reduce its capacity about 15% for a given temperature rise.

Use a splash-proof machine where there is danger of water or other liquid dripping on the motor. The frame of

TABLE I—HORSEPOWER AND SPEED

Ratings of Standard General-Purpose DC Motors

Hp	Rpm	Rpm	Rpm	Rpm
¾		1150		
1	1750	1150		
1½	1750	1150		
2	1750	1150	850	
3	1750	1150	850	
5	1750	1150	850	
7½	1750	1150	850	
10	1750	1150	850	
15	1750	1150	850	
20	1750	1150	850	575
25	1750	1150	850	575
30	1750	1150	850	575
40	1750	1150	850	575
50		1150	850	575
60		1150	850	575
75		1150	850	575
100		1150	850	575
125			850	575
150			850	575
200			850	575

TABLE II — CHARACTERISTICS AND APPLICATIONS OF STANDARD DC MOTORS

Type	Standard ratings, Hp	Speed regulation	Speed control	Starting torque	Peak-load capacity	Applications
Series	½ to 200	Varies inversely as the load. Races on light loads and full voltage	Zero to maximum depending on control and load	High. Varies as square of the voltage. Limited by commutation, heating, line capacity and bearing loads. Max., 500% full-load value	High. Limited by commutation, heating and line capacity. Max., 400% full-load value	Where high starting torque is required and speed can be regulated. Traction, bridges, hoists and cranes, gates, car dumpers, car retarders, etc
Shunt	½ to 200	Drops 5 to 10% from no load to full load	Any desired range depending on motor design and type of control	Good. With constant field, varies directly as voltage applied to armature. Max., 350% full-load value	High. Limited by commutation, heating and line capacity. Max., 300% full-load value	Where constant or adjustable speed is required and starting conditions are not severe. Fans, blowers, centrifugal pumps, conveyors, woodworking machines, metal-working machines, elevators, line shafts
Compound	½ to 200	Drops 15 to 25% from no load to full load depending upon amount of compounding	Any desired range, depending upon motor design and type of control	Higher than for shunt, depending upon amount of compounding. Max., 450% full-load value	High. Limited by commutation, heating and line capacity. Max., 350% full-load value	Where high starting torque with fairly constant speed is required. Plunger pumps, punch presses, shears, bending rolls, geared elevators, conveyors, hoists, crushers, etc

such a motor is so constructed that drops of liquid or solid particles coming toward the machine in any direction above 10 deg below the horizontal cannot enter it. Ventilation, from below the protecting hood, is restricted so that motor rating is reduced.

If even more protection is desired, use totally inclosed designs. With such motors, the air in them is separated from the outside by solid walls. This makes it difficult to dispose of the heat liberated inside the motor. Above 3-hp rating, these motors have a fan for circulating air between an inside and outside casing on the motor. Such machines are known as totally inclosed fan-cooled designs. This motor costs about 50% more than the open type.

For high temperatures and explosive gases, totally inclosed self-ventilated motors are sometimes used. These are totally inclosed except for two openings connected to a clean, cool air supply drawn through the motor by a fan on the armature shaft. Explosion-proof motors may be used where explosive gases are present.

There are other types of inclosures in use, but the ones mentioned are most commonly employed. Motors with acid-resistant-insulated windings are available for acid fumes.

Speed Control

▶ SPEED of a simple *series* motor can be varied by a resistance in series with it, Fig. 1. Current flowing through the resistor reduces the voltage across the motor, causing it to slow down below normal speed. After the speed is adjusted it is constant only as long as the load remains stable. If the load goes up, the motor slows down. Reducing the load causes a speed increase. This type of control is suitable only for constant loads or where the motor is under the control of an operator.

Fig. 2 shows a way to increase speed of a loaded *series* motor above full-load value by shunting a resistor across the field windings. Also, a combination of series and shunt resistance may be used to control series-motor speed from zero to above normal full-load value.

Speed of a *shunt* motor can be decreased below normal full-load value by armature resistance, Fig. 3, in the same way as the speed of a series motor is reduced. An adjustable resistance in series with the field winding, Fig. 4, is usually used to control speed of a shunt motor above full-load value. Speed of a general-purpose shunt motor can be increased about 25% without getting into trouble if the *motor is not overloaded.*

Adjusting either shunt- or compound-motor speed by field control is the most economical and satisfactory way. The shunt-field current is only about 5% of the total supplied to the motor. Consequently, the field rheostat is small, low in cost and the power losses in it are small. Once the speed is adjusted it remains practically constant with changing load. Motors of this type are known as *adjustable-speed* motors, because speed can be adjusted to some desired value and it stays put. On the other hand, motor speed controlled by regulating the armature current varies with load. Such motors are known as *varying-speed* machines.

When shunt-motor speed is to be increased more than 25%, a specially designed adjustable-speed type should be selected. Such motors are available for a speed range of 6 to 1; that is, if normal speed is 250 rpm, the field can be weakened to increase speed to 250x6 = 1500 rpm.

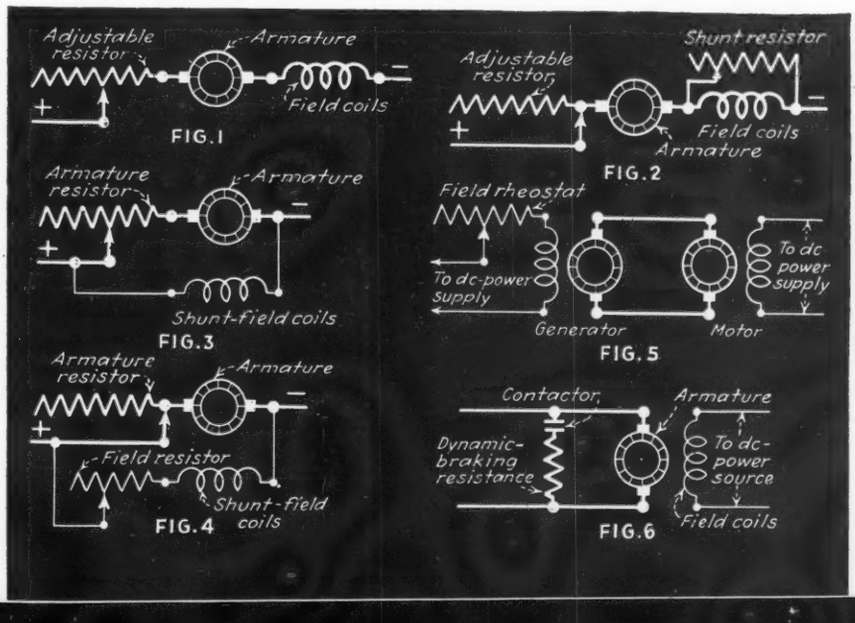
Compound motors do not lend themselves readily to speed control by adjusting shunt-field current, because the series winding partly compensates for any weakening of field strength by decreasing the shunt-field current. In other words, if magnetizing effect of the shunt winding is decreased, the series winding becomes more effective. On some applications, where a wide speed range is required, the series winding is used for starting only, being cut out as the motor comes up to speed. Then the speed of the motor can be adjusted by shunt-field control as with an ordinary shunt motor.

Where speed control is required over a very wide range, such as from near zero up to maximum, a combination of armature and field control is used, or a system of variable-voltage control is used, Fig. 5. With the latter, a generator is provided for each motor. The armature of the generator is tied directly to that of the motor.

Field coils of the motor and generator are supplied from a separate dc power source, such as a small generator driven from the main generator shaft. Motor field coils are excited at full voltage all the time and speed is controlled by regulating generator field current through a rheostat, as shown.

On hoists, elevators and other applications where the motor is started, stopped and reversed frequently it is made to act as a brake to slow down the load. This is done by leaving the field coils energized, disconnecting the armature from the power source and connecting a resistance across its terminals, Fig. 6. Connecting resistance across the armature causes the motor to become a generator, thereby producing a braking action (dynamic braking) inversely proportional to circuit resistance.

Figs. 1-6—Methods of adjusting speed: (1) Adjustable resistor in series with series motor, (2) resistor connected in shunt with field coils of series motor, (3) adjustable resistor in series with shunt-motor armature, (4) resistor in series with field coils of shunt motor, (5) diagram of variable-voltage system of speed control, and (6) diagram of dynamic braking circuit



Brushes and Brush Setting

▶ GOOD OPERATION of direct-current machines, in a large measure, depends upon selecting proper brushes, correctly fitting them into the brush-holders and onto the commutator, their location on the commutator and the condition of the commutator surface. If anyone of these conditions are not correct, sparking or other troubles may result.

Brushes used on electric machines are of many grades, current-carrying capacities and characteristics. Current-carrying capacity is the current in amperes per sq in. that a brush will carry without seriously overheating.

Other characteristics affecting brush operation are abrasiveness, hardness, contact resistance and coefficient of friction. In general, brushes should be practically non-abrasive, but for some applications where commutators operate with flush mica, a slight amount of abrasiveness may be desirable to wear down the mica flush with the copper.

Hardness of a brush has less influence on its operation than any other characteristic. Of two grades of brushes, where other conditions are equal, the harder will last longer and will polish a commutator better than a softer brush. The softer brush will operate more quietly and have less tendency to chatter and vibrate than the harder grade.

Resistance of contact that the brush makes with the commutator has more influence on performance than any other property. This characteristic is also referred to as contact drop, meaning the volts drop across the contact between brush and commutator. In general, the higher the contact resistance of a brush on the commutator, the less likely it is to spark. On the other hand, excessive contact resistance may cause objectionable heating, power loss and other troubles.

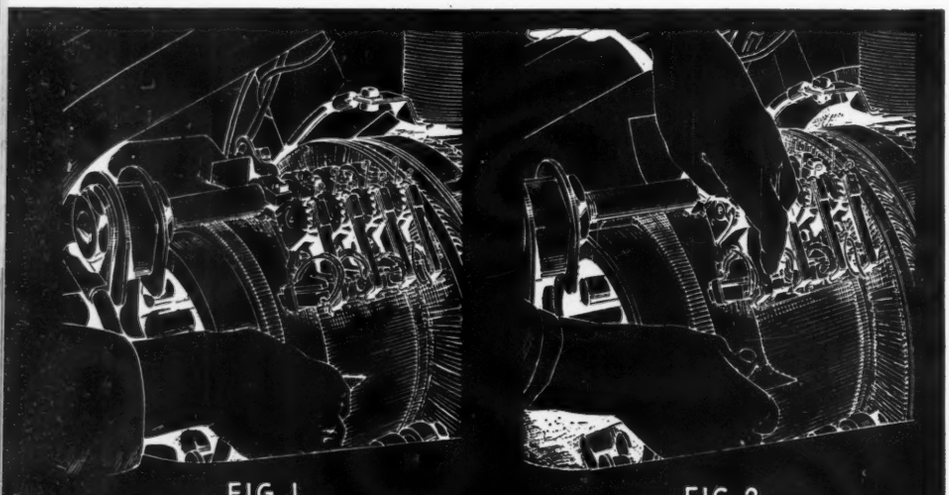


FIG. 1

FIG. 2

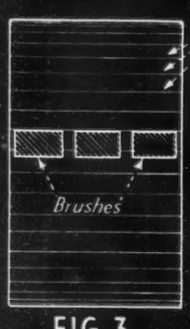


FIG. 3

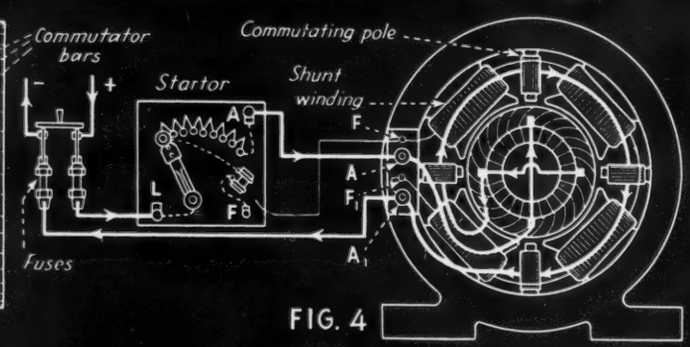


FIG. 4

Coefficient of friction of a brush determines the peripheral speed of the commutator on which it may be used without excessive heating or chattering. Usually, the higher the commutator speed the lower the coefficient of friction of the brush should be.

The next problem is to properly fit brushes to the commutator. This may be done with sandpaper placed with the sand against the surface of the brush, Fig. 1. Rough fitting may be done with coarse sandpaper moved back and forth under the brush. Final fitting should be done with fine-grade paper pulled in the direction of commutator rotation only, Fig. 2. Soft grinding-in stones are available for fitting brushes to their commutator while the machine is running without load. The stone is held on the commutator back of the brushes. As the commutator turns, stone particles are carried by the commutator under the brushes, grinding them to fit.

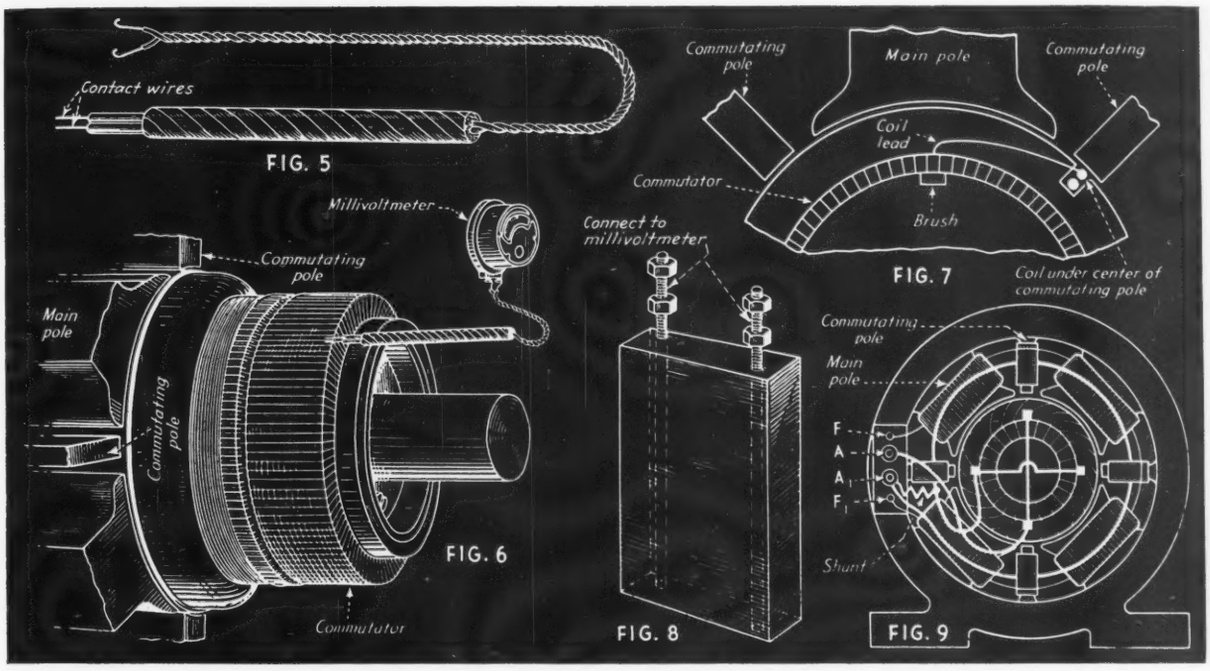
Line Up Brushes

After the brushes are fitted, the commutator and brushes should be thoroughly cleaned, first by a vacuum cleaner and then by careful wiping with a clean cloth. Each group of brushes should line with a commutator bar, Fig. 3. Sometimes, due to defective insulating washers, a bent brush-holder stud, or because the holders are not set an equal distance away from the commutator, the brushes will not be in line. Whatever the cause, this condition should be corrected.

Next, space the brushes equally around the commutator. This is done by counting the number of commutator bars and dividing this number by the number of poles in the machine. Then, loosen the brush yoke and bring the face of one brush group to the edge of a commutator bar. Count the bars between the groups to see if the number checks with the figure obtained by dividing the total by the number of poles.

When brush-holder and their studs are placed an equal distance from the commutator and are in good condition, then the brushes should be equally spaced. If they are not, loosen the brush-holders and move them up or down to get equal spacing between the brush groups. Any movement of the brush-holders to adjust position of the

Figs. 1 and 2—Fitting brushes to commutator with sand paper. Fig. 3—Brushes in each group should be in line. Fig. 4—Field circuit open to test brush location on commutator



Figs. 5 and 6—Locating neutral on commutator with millivoltmeter. Fig. 7—Armature-coil lead locates neutral. Fig. 8—Fibre brush used with millivoltmeter. Fig. 9—Shunt across commutating-pole coil leads to adjust field-pole strength.

brushes requires refitting them onto the commutator.

After the brushes are properly fitted and adjusted, they must be accurately located on the neutral of the commutator. In the factory, brush position is usually carefully located and marked on the brush-holder yoke and its stationary support. Occasionally, the operator has to check location of the brushes on the neutral, particularly if the machine is giving trouble. Under such conditions, check the circumferential spacing of the commutating-poles around the armature. Also check the air gaps between the pole-faces and the armature of all the poles. These should be equal.

There are several ways of locating neutral on the commutator. If the field circuit is opened, on a shunt motor, as in Fig. 4, and the starter brought onto the first point, the motor will not start if the brushes are on the neutral. Shifting the brushes away from neutral will cause rotation in the direction in which brushes are moved.

If the top leads from the armature coils can be followed, place the armature so that one of its slots is directly under the center of a commutating-pole, Fig. 7. Then follow the lead from this slot to its commutator bar, which is approximate neutral.

An accurate method is to use a millivoltmeter to find a position on the commutator where voltage obtained between two adjacent bars is zero. This may be done with a pair of leads as in Fig. 5, and a millivoltmeter. With the machine running under no load, move the contacts around the commutator, Fig. 6, until the millivoltmeter reads zero. This is the no-load neutral and the brushes should be set on it. Then put full load on the machine and again test for the neutral position. It should be at the same position on the commutator as at no-load if the commutating-poles are of the correct strength.

Locating Neutral

In place of the leads, Fig. 5, a fibre brush with two contacts, Fig. 8, may be used. Place the brush in one of the holders and connect the millivoltmeter to the two contacts, which are spaced to rest on adjacent commutator bars.

If the load neutral shifts ahead of the no-load neutral on a motor and behind on a generator, the commutating-poles are too strong. The reverse indicates weak commutating poles.

When the commutating-poles are too strong, it may be possible to weaken them by removing iron shims between their pole-pieces and the field frame. This will increase the air gap between the commutating-pole faces and the armature. If a shunt, Fig. 9, has been used to adjust the current through the commutating-pole coils, increasing the cross section of this shunt will reduce the current through the coils and the strength of the pole-pieces. When there is no shunt, one may be made of a german-silver strip of proper length and cross section, which will have to be determined by trial. On small- and medium-size machines, turns may be removed from the coils.

Unless the air gap between the commutating-pole faces and the armature is short, soft-iron shims may be placed between the pole-piece and frame to reduce the air gap and increase the strength of the poles. These shims must cover the entire area between the pole-pieces and frame. Unless the shims make a good tight fit between the pole-pieces and frame, a large part of the effect of reducing the air gap may be lost.

It may be possible to add turns to the commutating-pole coils to increase their field strength. When a shunt has been connected across the commutating-pole-coil terminals as in Fig. 9, reducing the cross section of the shunt will cause more current to flow through the coils, thereby increasing the field strength. All these cures have to be applied by cut- and try methods, but a little careful experimenting should produce the desired results.

Of course, it isn't usually necessary to adjust the commutating-pole strength, as this should be adjusted properly before the machine leaves the factory. However, poor connections at the shunt or between the field coils, or loose bolts holding the pole-pieces can change the strength of the commutating poles. If a machine is discovered to have incorrect commutating-pole strength, first make sure that all connections are clean and tight and that the pole-pieces make a good, clean, tight fit to the frame.

Inspection and Maintenance

▶ AN INTELLIGENT INSPECTION program is the backbone of every worthwhile maintenance system. When equipment inspections are properly scheduled and made, most of the little defects will be found and corrected before they cause prolonged shutdowns and expensive repairs.

Every inspection and maintenance program should begin when the equipment is installed. Motors and control should be properly protected against atmospheric and other local conditions. Also provide adequate electrical protection against overloads and make sure that it is properly adjusted and in good working order. Lack of this protection can cause expensive repairs.

Responsibility for equipment conditions that effect operation is important to the success of inspection work. Each man in the inspection crew should be assigned a given number of motors and be made responsible for cleaning and lubricating them, adjusting belt tension and adjustment of overload and other protection, and reporting high-temperatures or other conditions that affect operation.

Keep a Record

Give each motor and its control a number. Maintain a record of pertinent data and information on performance of each piece of equipment. Keep a record of repairs and cost. It may be found cheaper to junk certain machines than to keep them in service.

Local conditions will influence inspection schedules and maintenance programs in different plants. Where operating conditions are severe, motors and controls require more attention than those more favored. Make inspections frequently enough to prevent unexpected failures.

Make routine load and insulation-resistance tests and keep a record of them (see page 90). Make load tests at least once a year and more frequently if motor temperature rises abnormally. When load on a motor is controlled by the machine operator, place a recording ammeter where the operator can see it and connect it into the motor circuit. This will show the operator how to control the load and give a permanent record of it.

Cleanliness is paramount in maintenance work. By doing a thorough cleaning job you will find the little defects that may later develop into serious trouble. Cleaning is usually done by wiping, with compressed air or by vacuum. The latter is preferred. Compressed air blows the dirt out of the machine to be wiped up, whereas a vacuum cleaner removes it without even creating dust. A strong blast of compressed air might injure insulation if held near it.

Dust and dirt form a lodging place for moisture, grease and fumes, which, if not removed, attack the insulation and other parts. Frequently, motor insulation is irreparably damaged because of neglecting the simple rules of cleanliness. Exercise care when lubricating motor bearings. Too little lubricant may ruin the bearings and too much will damage the insulation. Watch oil rings on sleeve bearings to see that they run freely. When a motor is given its periodic overhauling, clean bearings and renew lubricant.

On direct-current motors, the brushes and commutators are the most vulnerable spots and should be watched carefully. But, even here, if these parts are kept clean, very little trouble should be experienced. Don't let carbon and copper dust collect on brush-holder insulators. Keep slots of undercut commutators clean.

Opposite sides of a motor and control record card

MOTOR AND CONTROL DATA

Rating, Hp	F-L Speed	F-L Amp	Volts	Phases	Cycles	Mill No.	Card No.
Make	Type	Form	Frame No.	Temp. Rating		Winding Diagram No.	Application

Serial No. Model No.	Publication No.	CONTROL EQUIPMENT Type Make Pub. No.
BRUSHES No. per Motor Cat. No. Size Material Grade	COILS (Cat. or Spec. No.) Field { Shunt / Comm / Series Stator Rotor or Armature	
BEARINGS Front End, Cat. No. Pulley End, Cat. No. Journal Diam	Coils Bars No. per Set	Connection Diagram
PULLEY Diam Face Belt Width Bore Keyway	Mfr's Order No. Our Order No Date of Order Cost { Motor / Control	Location
REMARKS		

SERVICE RECORD

Date	Building	Floor	Driving	Drive	Tested Hp

REPAIRS

Date	Condition	Due to	Repaired by	Cost

Troubles and Remedies

▶ SINCE MOST ALL TROUBLES with direct-current motors result in sparking at the brushes and commutators, this is the most logical place to start discussing faults and their remedies. Rough and worn commutators, improper grades of brushes, brushes not properly spaced and fitted or set on neutral, defective field coils or too weak magnetic field, poor shunt connections between brushes and brushholders, defective armature coils, overloads, worn bearings, faulty drives and other conditions all may cause sparking at the brushes.

Condition of the commutator may be affected by high mica, high commutator bars, commutator worn in ridges and flat spots. When commutators used to operate with flush mica, as in Fig. 1, the copper bars frequently wore faster than the mica, which left the latter extending above the commutator surface. Resurfacing the commutator gave temporary relief only, until the copper had worn below the mica again. Slightly abrasive brushes were also used to help wear down the mica.

Today, it is common practice to undercut the mica below the copper, Figs. 2 and 3. If the slots can be kept clean easily, a square slot (Fig. 3) is preferable. Where the slots are likely to collect dirt, as on slow-speed machines or in a dirty atmosphere, the V-shaped slot (Fig. 2) may be more satisfactory. With either type of slot, slightly bevel the segment corners, particularly on V-shaped slots (Fig. 4) to insure that mica will not be left flush with the commutator surface.

Various types of undercutting tools are available, ranging from slotting files (Figs. 5 and 6), a piece of hacksaw blade held in a wooden handle (Fig. 7), to power-driven tools (Figs. 8 and 9). After the undercutting is done, polish the commutator with a fine stone made for this purpose. Figs. 10 to 12 show different types of commutator stones. Stones may be held in the hand (Fig. 13), but adjustable rests are available for holding the stones (Fig. 14) on medium- and large-sized machines. After the commutator has been conditioned, make sure that it is free of every trace of copper, carbon and other dust. A little dust lodged in between the commutator bars may cause a lot of trouble later.

If the commutator wears in ridges, armature end motion will cause the ridges to lift the brushes and produce sparking. Uneven wear can be prevented by tracking the brushes in one group so that they ride on the spaces between an adjacent group, Fig. 15.

Fig. 1—Flush mica in commutator. Figs. 2 to 4—Undercut mica in commutators. Figs. 5 and 6—Files for undercutting mica in commutators. Fig. 7—Hacksaw mica undercutter. Figs. 8 and 9—Power-driven commutator undercutters

Commutator Flat Spots

Flat spots on commutators may develop from several causes, such as commutator out of round, brushes too loose in holders, insecure mounting of brushes, loose bearings, pounding of reciprocating machines, and mechanical unbalance of the rotating element. The cures for these faults are self-evident.

Brushes too loose in the holders, commutators out of round, brushes with too high coefficient of friction or too high specific gravity, will cause chattering and produce flat spots on the commutator. Clamp-type brush holders, Fig. 16, should never be used on high-speed commutators. Inertia of the holders, added to that of the brushes, may multiply the effect of very slight unevenness on the commutator surface and cause serious chattering.

When brushes are operated in a stubbing direction, Fig. 17, they should be inclined 30 deg or more to the commutator's center line. This will keep them from tipping up on their toes and chattering. For trailing operation, Fig. 18, the best angle of inclination is generally between 12 and 15 deg. If this angle is too large, a wedging action of the brush between

the commutator and trailing side of the holder causes excessive friction and a sluggish brush action in the holder.

For a discussion on how brush quality, fitting of brushes on the commutator and their location on the neutral affect operation, see "Brushes and Brush Setting," page 84.

Keep the brushes and holders wiped clean and make sure that they move freely in their holders when they are either hot or cold, to prevent brushes sticking in holders and sparking. Adjust tension springs to hold brushes on commutator with a firm even contact of about 1.5 lb per sq in. of brush cross-section.

A weak magnetic field will cause sparking at the brushes and excessive speed if the motor operates, but frequently it will not start, as when the field circuit is open and the brushes are set on neutral. To test for an open field circuit, open the armature circuit and close the starter on the first point, Fig. 19, and then open the line switch. If the field circuit is closed, an intense spark will be present. Absence of spark shows an open field circuit.

How to Find Open Circuit

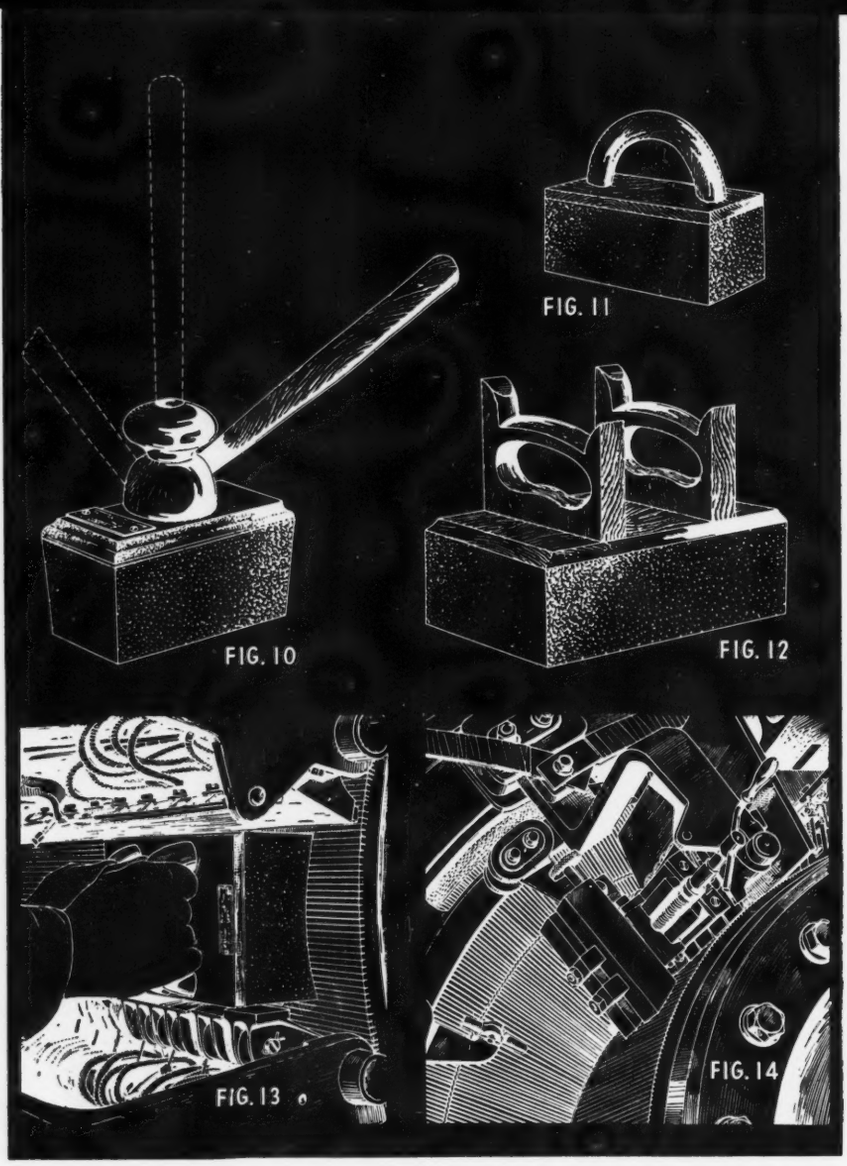
To find whether an open circuit is in the motor, the connecting wiring or the starter, connect a lamp to the field-coil terminals at the motor, Fig. 19. If the lamp lights it shows power is reaching the motor and the "open" must be in the field-coil circuit. Absence of a light indicates an "open" in the part of the circuit outside the motor. It is then only a matter of testing the different parts of the circuit with a lamp to find the fault.

When the fault is in the coils, first check the connection between them. If the defect is not found there, open the armature circuit, close the switch, and bring the starter onto the first point. Then, with a lamp, bridge the field coils as in Fig. 20. When the defective coil is shunted the lamp will light.

In a shunt motor, a weak magnetic field can be caused by a short-circuited field coil. If the field coils are left in circuit, the good coils will heat while the defective coil remains cool. A test for the defective coils can be made with a lamp, or better still, a voltmeter, as in Fig. 21. If the defective coil is completely short-circuited, the lamp will not light when connected to its terminals. When only part of a coil is short-circuited the lamp will not be very bright. When a voltmeter is used instead of a lamp, a coil giving a low reading is the defective one.

A ground in one of the field coils, if the power circuit is grounded, will short part of the coils out of circuit. This will weaken the magnetic field and cause part of the coils to heat. A test for this fault, when the frame of the machine is insulated, is made as in Fig. 22. If coil *C* is grounded, a circuit will be completed as indicated, through coils *A* and *B*, part of coil *C* and through the frame to the minus sign side of the line. To locate the defective coil, open the connections between them and test each one to ground. The defective coil will light to ground. When one side of the line and the frame of the machine are grounded, be sure test lamp is connected to ungrounded side of the line.

On a new machine or one recently repaired the field coils may have wrong polarity. The coils should produce alternate *N* and *S* poles in the polepiece, as in Fig. 20. To test polarity of the field poles, connect the coil to the line and put a piece of iron from one polepiece to the other. If the coils have correct polarity they will attract the iron with a strong pull. A weak pull or a repelling of the iron indicates wrong polarity. This test can also be made with a compass which should point alternately north and south when presented to adjacent poles.



Figs. 10 to 13—Hand stones for grinding commutators. Fig. 14—Commutator stones mounted on a special rest on a brush-holder stud

Compound Motor

On a compound motor the shunt-field coils can develop all the defects that they do in a shunt motor to produce a weak magnetic field. In addition to these faults, the series and shunt coils may have opposite polarity. See Figs. 14 and 15, page 81, on how to test polarity of series and shunt field coils on a compound motor.

Overloading a motor may cause sparking at the brushes and excessive machine temperature. Short-circuits, open circuits, grounds and incorrectly connected coils in the armature form another group of faults that cause brush sparking. A short-circuit in a coil will cause it to heat excessively and may destroy its insulation in a very short time. When the fault is

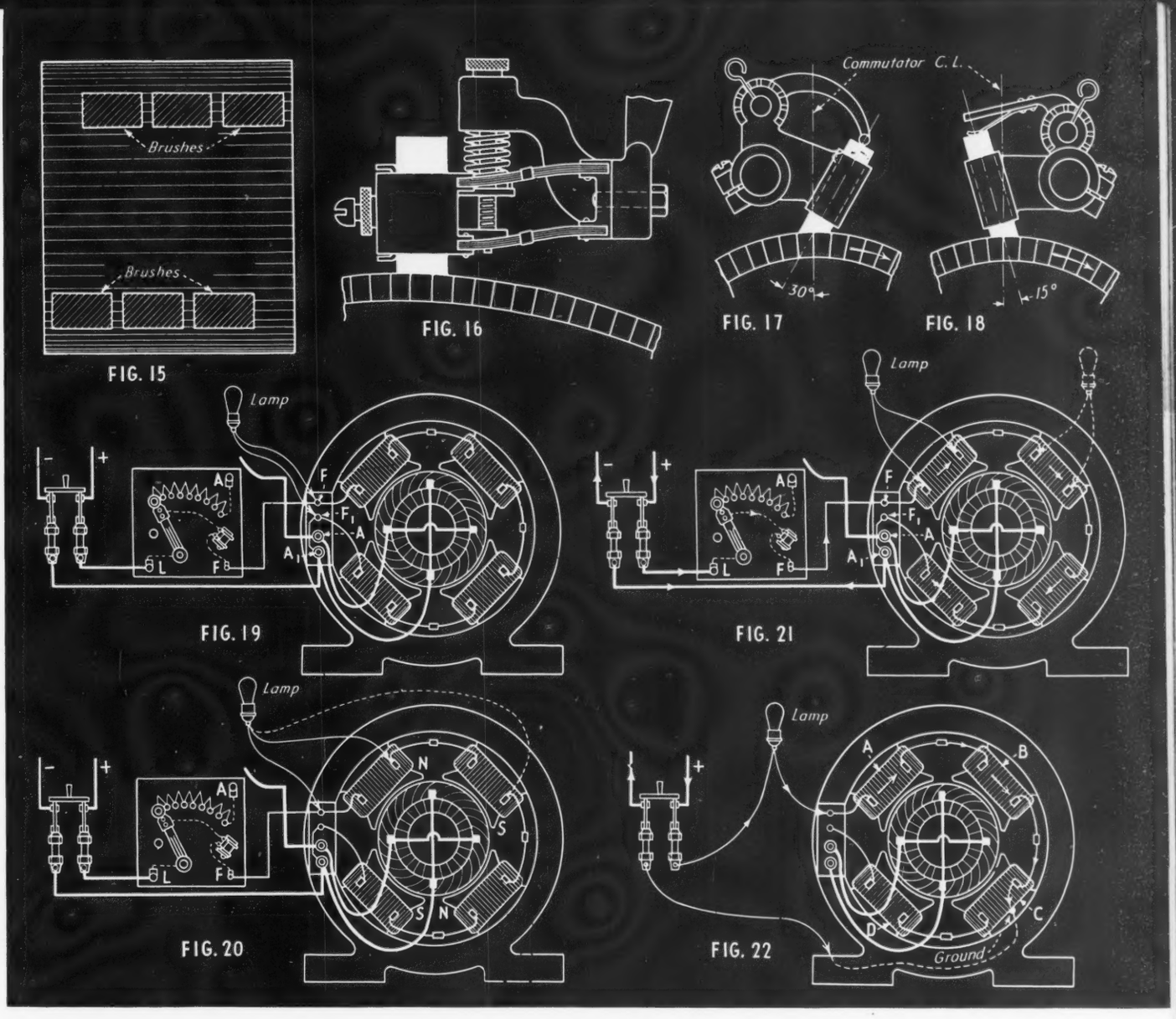


Fig. 15—One brush group set to track between brushes. Figs. 16 to 18—Types of brush-holders. Figs. 19 to 22—Testing for field-coil faults.

between two commutator bars, these bars will usually heat excessively along with the coil connected to them.

An open circuit in an armature coil will cause vicious sparking at the brushes and burned spots on the commutator. This defect can be temporarily repaired by bridging the two commutator bars together between which the burning occurs. On a series-wound armature, bridge only one burned spot.

A ground in the armature of a motor with its frame grounded and operating on a grounded power system will blow the fuse or open the circuit breaker. A similar effect will occur if the brush-holder studs are grounded to the rocker arm. The latter may be caused by copper and carbon dust getting on the insulators or failure of an insulator. These faults can generally be found by inspection.

Heating of sleeve bearings, second in importance to brush sparking, may be caused by lack of lubricant or lubricant of poor quality, stuck oil ring, dirt, grit or other matter in the lubricant, bearing in poor condition or worn so that the armature runs close to the bottom polepieces, bearings too tight, belts too tight, defective gears, bent shaft, bearings out of line, bearings that prevent armature from aligning with the polepieces, etc.

Anti-Friction Bearings

In high-speed anti-friction bearings, too much lubrication may cause heating by the pumping action of the bearing. A slightly acid lubricant will attack the balls, rolls and races, produce heating and eventually ruin the bearing. Many of the causes of heating of sleeve bearings, such as out of alignment, excessive thrust and radial loads, etc, apply to anti-friction bearings.

When a motor stops and fails to start, the fault may be due to the fuses or circuit-breaker opening, broken power wires, dead power line, poor connections, brushes shifted off neutral, open field circuit, open starting resistance, ground in armature or field coils, overload, and, on small machines, brushes may stick in the holder.

The remedies for most of these troubles are evident with the exception of overloads. Before a motor is required to start a load, be sure the load can be started. Because a machine ran freely before it stopped is no indication it can be started again. At the first sign of difficult starting, cut the power out of the motor and make certain the load is free to start.

A wide variety of tools, other than those mentioned, are available for inspection and maintenance work. These include portable blower and vacuum cleaners to assist in doing the cleaning job, portable grinding and polishing wheels, portable drills and compressed-air varnish sprayers. Testing devices for measuring insulation resistance, locating faults in machine windings, making load tests, locating circuit faults, are also available.

Insulation Resistance

▶ INSULATION HAS A LOT of enemies, such as moisture, dust, dirt, alkalies, acids, oil and other substances. The effects of some of these are permanent; others are only temporary. When a machine stands for a long time in a damp atmosphere its insulation deteriorates by absorption of moisture. This condition can generally be corrected by drying out the windings. But, insulation may be permanently injured if it becomes wet and the drying is not properly done.

What is good insulation and how to determine when it is good have been much discussed. These questions are still far from being definitely answered. However, two generally accepted methods of measuring insulation quality are in common use: insulation-resistance measurement and high-voltage test. It is now quite generally agreed that a high-voltage test should be applied to new machines only.

Insulation Quality

The generally accepted test for insulation quality is to measure its resistance. This test is not infallible, but if intelligently made and interpreted, it serves as a highly reliable guide, particularly if made periodically. A safe minimum insulation resistance of a machine varies with its physical dimensions, voltage, temperature and other conditions. Several formulas, all giving different values, have been developed for arriving at a safe minimum value of insulation resistance.

Many operating and insurance engineers take the point of view that the only purpose for which insulation resistance is measured is to determine if a machine is in safe operating condition. For this purpose, they have established a value of safe minimum insulation resistance based on machine voltage. This minimum value in megohms equals rated voltage of the machine divided by 1000, with a minimum of one megohm for all machines rated 100 to 1000 volts. This rule requires that a 2300-volt machine must have an insulation resistance of $2300 \div 1000 = 2.3$ megohms. The rule has the advantage of being simple, but it does not differentiate between machines of different capacities and speeds. However, experience has shown that the rule has worked out fairly well in practice.

Insulation Resistance

Two methods of measuring insulation resistance are in common use: one measures the voltage drop through the insulation. From this value and the resistance of the voltmeter, insulation resistance can be calculated. The other makes use of a direct-reading megohmmeter.

The first method requires a permanent-magnet voltmeter of known resistance and a source of direct current of not less than 110 volts. The voltmeter is first connected across the line to determine the available voltage. It is then connected in series between the winding and frame of the machine, Fig. 1. In the illustration, the circuit is connected between the commutator and frame, which applies the voltage across the armature insulation. Assume that line volts $E = 225$, voltmeter reading $e = 3$ volts and resistance r of the voltmeter is 30,000 ohms. Then the insulation resistance R may be found by the formula:

$$R = \frac{r(E - e)}{e} = \frac{30{,}000 \times (225-3)}{3}$$

2,220,000 ohms,

or 2.222 megohms. This value, according to the rule given above, indicates that the machine is in safe operating condition.

Megohm-meters are now generally used for making insulation-resistance measurements. This instrument consists essentially of a direct-reading, permanent-magnet, moving-coil, ohmmeter mounted in a case with a specially designed, hand-driven dc generator. Its pointer is deflected across a scale, as in a voltmeter, to indicate directly the insulation resistance in ohms or megohms, depending upon the type of instrument and its scale range. When making an insulation test on a dc machine, connect the instrument as in Fig. 2, turn its crank and read the insulation resistance on the scale.

Periodic Tests

One reading of insulation resistance does not tell very much about its quality. Tests should be made periodically and a record kept of them on a form similar to Fig. 3. Make out a card for each machine. Such a record will show what is happening to the insulation. A high insulation resistance does not necessarily indicate that the machine is in good condition unless consistently high readings are obtained on each test.

How frequently insulation tests should be made depends upon local conditions. In dry clean atmosphere, two years between tests may be sufficient; in the presence of moisture, acid fumes, or conducting dusts, tests every three months may be necessary. The real answer is: make tests often enough to prevent unexpected breakdowns.

Fig. 1—Measuring insulation resistance with voltmeter. Fig. 2—Megohm-meter measures insulation resistance. Fig. 3—Record form for keeping track of insulation resistance

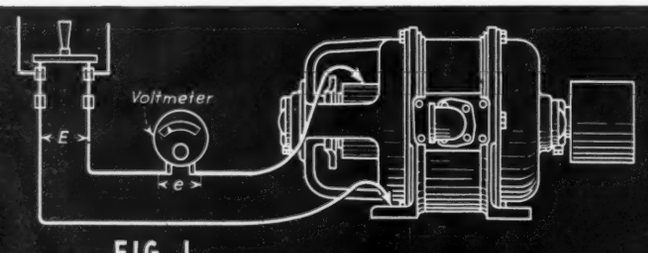


FIG. 1

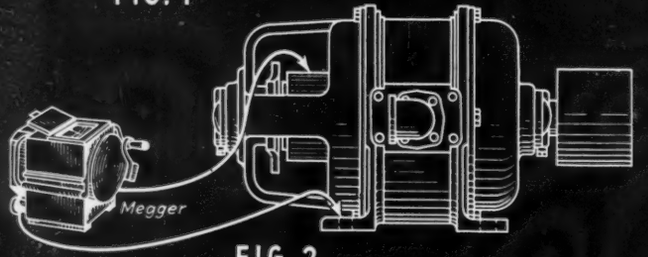
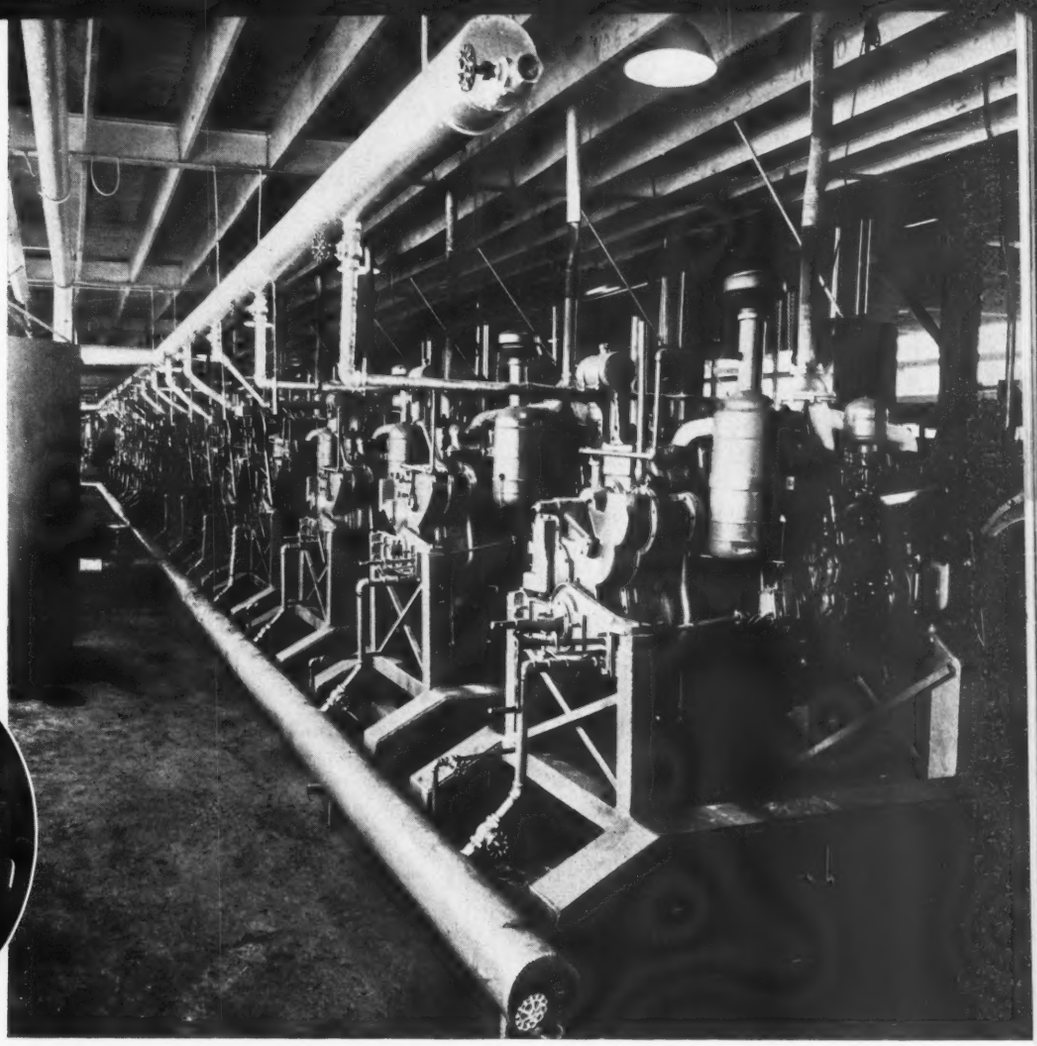


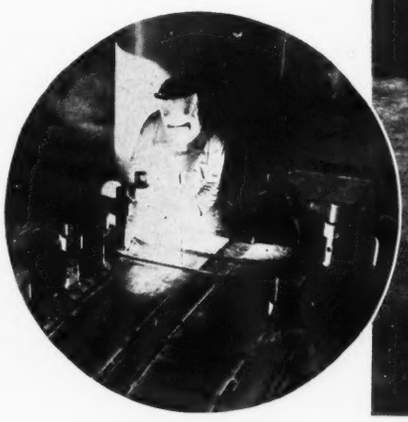
FIG. 2

Date	Time	Insulation Resistance Megohms	Temperature Deg F	Weather	Remarks

FIG. 3



Twenty Caterpillar diesels drive 17 generators at R G LeTourneau plant, Peoria, Ill. Note common jacket-water headers



Twenty Diesels All in a Row

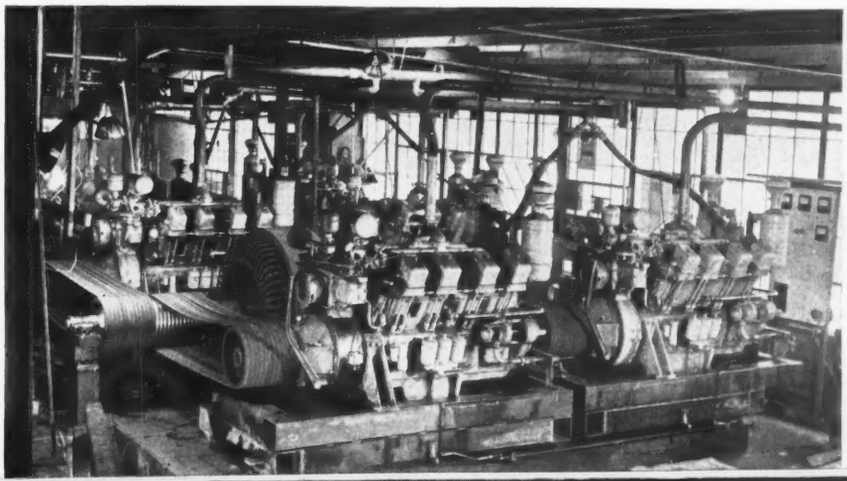
STARTING with one diesel engine and generator in 1936, R G LeTourneau, Peoria, Ill., has met its increasing power demands by adding engine after engine until today it has: thirteen 125-hp units direct-connected to 60-kw ac generators; two 160-hp, 80-kw ac units; and four 160-hp, V-8 engines connected by V-belts to one 320-kw, ac generator. A 125-hp diesel connected to a 55-kw dc generator supplies exciting current for the ac sets. A voltage regulator controls its output.

The power problem here is unusual, because at peak operation energy must be provided for 235 welders in addition to that for hundreds of motors, well pumps, lighting, and miscellaneous items. Peak load is in the neighborhood of 1260 kw and average load from 950 to 1000 kw. The multiple installation supplies necessary high flexibility, because needed power requirements can be met by running at high load factor —and hence high efficiency and economy—the necessary number of engines. There is no standby.

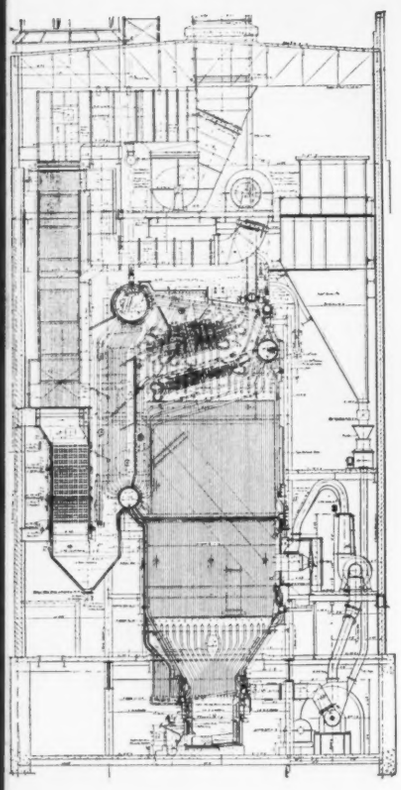
Each engine draws cooling water from a single header parallel to the long line of engines. Used water flows into a second header which carries it to a tank, and thence into the cooling system. The latter is a simple trough passing around a series of pipes cooled by artesian well water.

Fuel is supplied to each engine from a main pipeline which runs along the floor. Carload lots of the fuel are purchased and stored in one of two 14,000-gal. tanks placed on a level with engines. Average daily fuel consumption is 1500 gal.

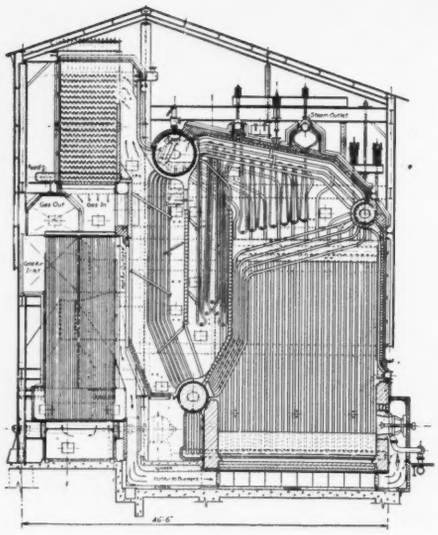
Four 160-hp diesels drive one 320-kw ac generator through multiple V-belts. Clutches permit operating one, two, three or all four engines at one time



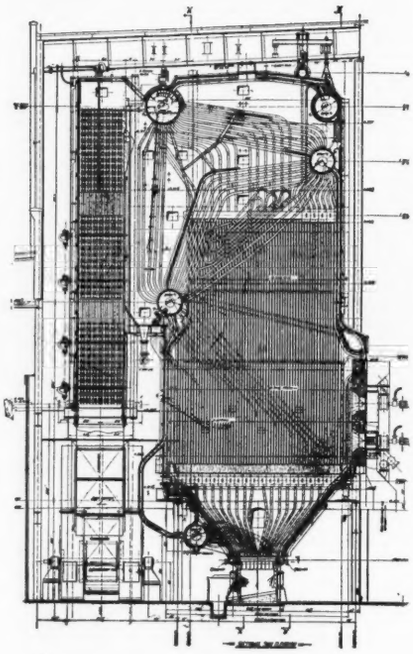
....Typical Recent Installations



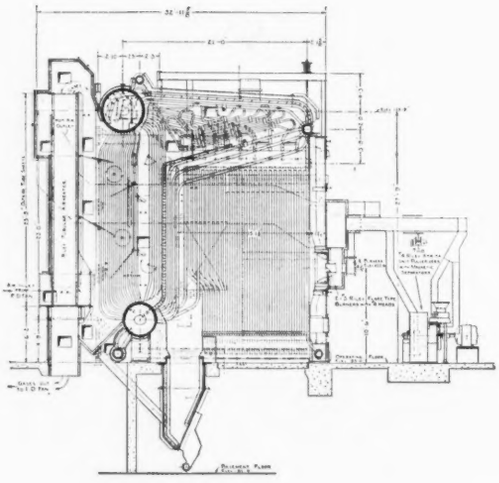
Central Illinois Light Co., Peoria, Ill.
300,000 lbs./hr. 900 lbs.–875°F.
This company recently placed an order for a 375,000 lb. Riley Unit



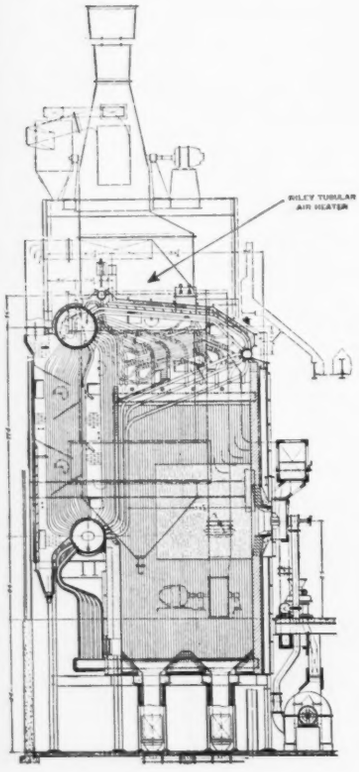
Large Texas Public Utility
250,000 lbs./hr. 975 lbs.–910°F.



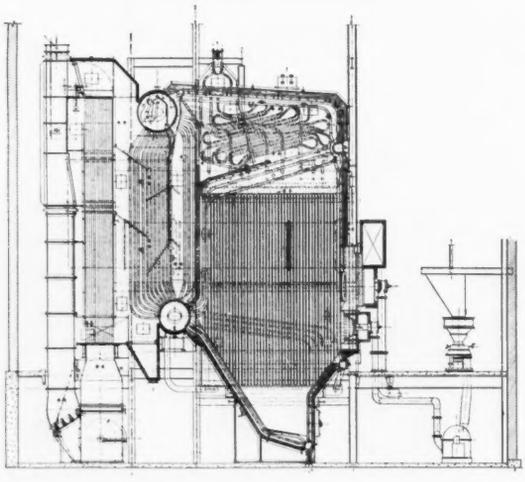
Large Eastern Oil Refinery
300,000 lbs./hr. 750 lbs.–740°F.
This is the third order for similar units since 1934



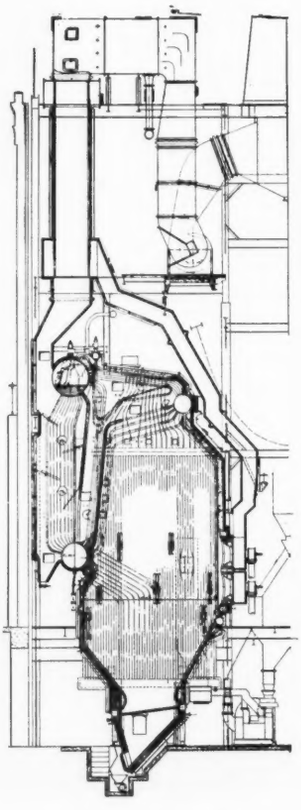
Northern Paper Mills, Green Bay, Wis.
75,000 lbs./hr. 700 lbs.–700°F.
Sargent & Lundy, Engineers



Winchester Repeating Arms Co.
New Haven, Conn.
75,000 lbs./hr. 725 lbs.–750°F.
Arthur L. Nelson, Engineer



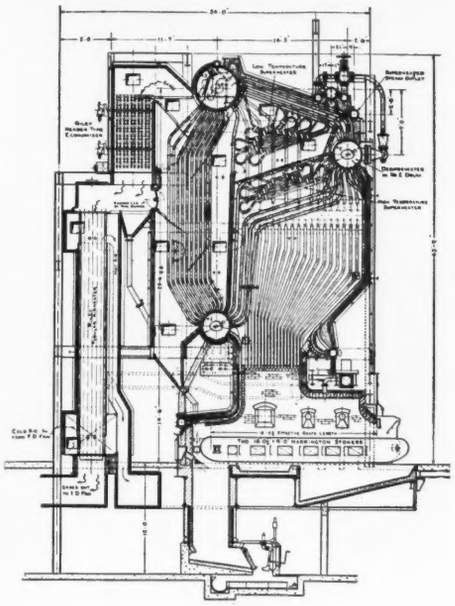
Union Public Service Co., Canby, Minn.
75,000 lbs./hr. 500 lbs.–825°F.
Ralph D. Thomas, Engineer



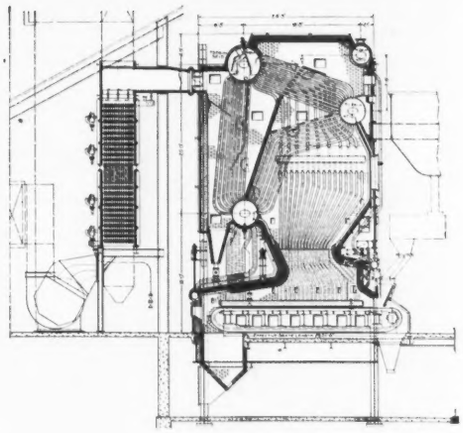
Allis Chalmers Mfg. Co.
Milwaukee, Wis.
150,000 lbs./hr. 200 lbs.–452°F.

It will pay you to visit modern Riley Installations

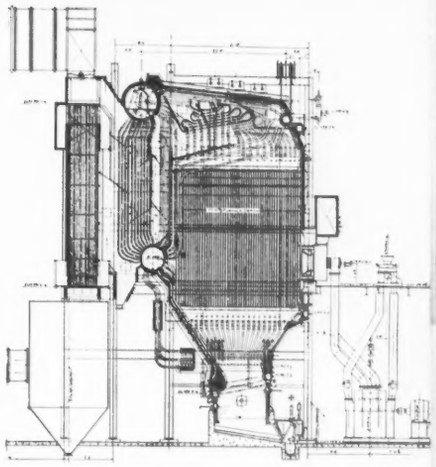
# of RILEY steam generating units



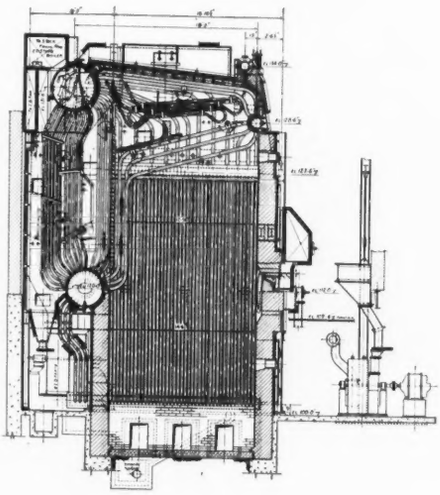
Otter Tail Power Co., Wahpeton, N. D.
130,000 lbs./hr. 650 lbs.–825°F.



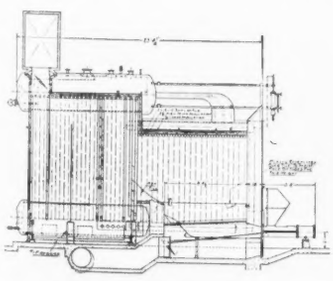
Ohio Salt Company, Rittman, Ohio
120,000 lbs./hr. 275 lbs.
H. M. Wilson Co., Engineers
This company has just placed an order for a duplicate unit



Shell Oil Company, Wood River, Ill.
125,000 lbs./hr. 700 lbs.–750°F.



Agfa Ansco Co., Binghamton, N. Y.
61,000 lbs./hr. 475 lbs.–700°F.



Pet Milk Co., Coldwater, Ohio
25,000 lbs./hr. Riley "RO" Unit
Pet Milk Co. has placed nine different orders for Riley "RO" Boilers

If you want to see modern steam generating equipment built as it should be built visit any of the Riley installations shown or any other recent Riley installations.

When you do so you will find boiler equipment which meets today's demand for extreme economies and trouble-free operation . . . equipment which not only met guarantees but in many cases exceeded them. You will also be impressed by the excellent appearance of the equipment and realize that a casing so constructed is not only tight to start off with but stays tight after years of service.

Then it will be apparent to you why there has been such a decided swing during recent years to Riley Boiler and Fuel Burning Equipment . . . why so many of the country's leading industrial and central station plants have selected Riley equipment . . . why we are justified in saying "It will pay you to visit modern Riley installations before purchasing boiler or fuel burning equipment."

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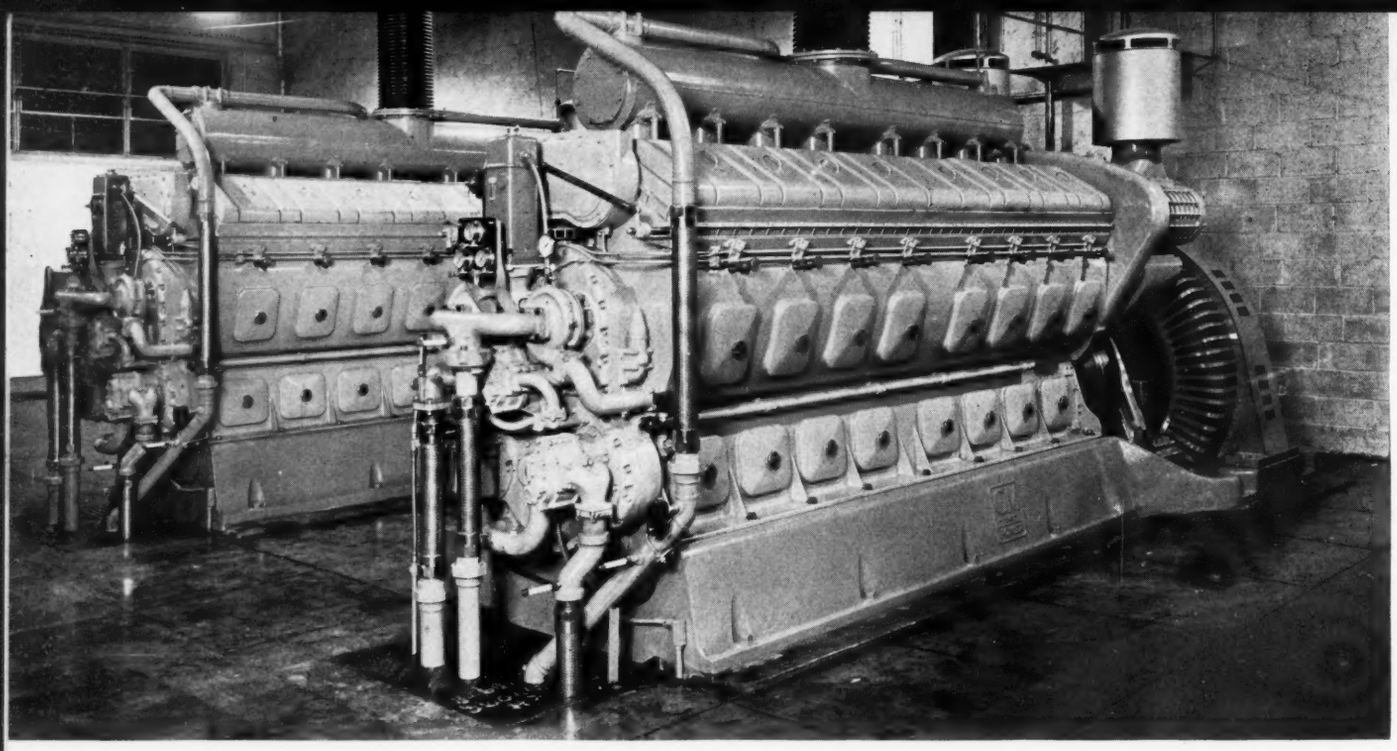
AIR HEATERS • ECONOMIZERS • STEEL CLAD INSULATED SETTINGS
WATER-COOLED FURNACES • FLUE GAS SCRUBBERS

before purchasing Boiler or Fuel Burning Equipment

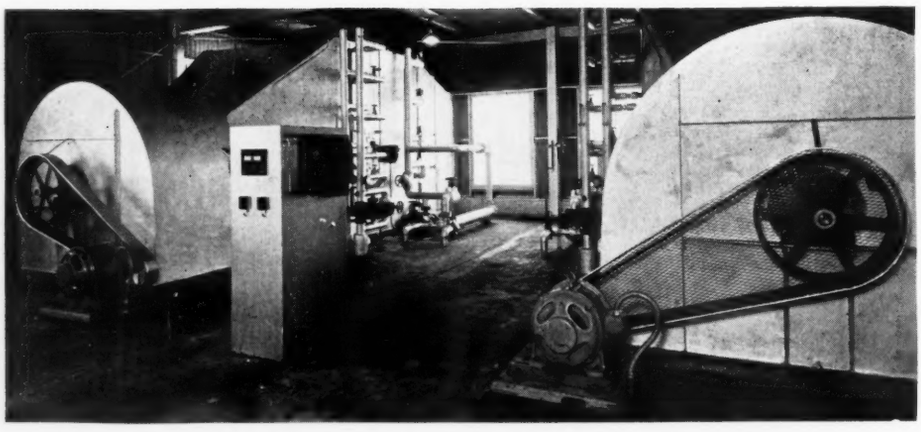


These two 12-cylinder diesels, plus two 6-cyl units, supply all the power needs of General Motors' Allison Div airplane-engine factory

Diesels for Streamlined Factory

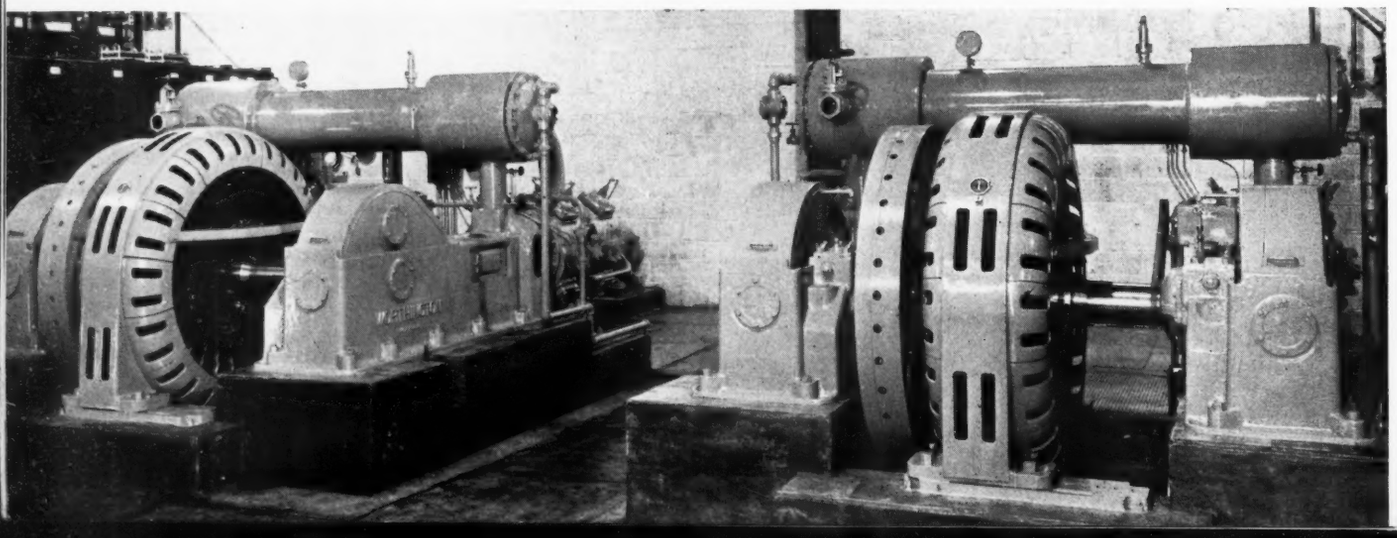
AMERICA'S NEWEST VERSION of a completely air-conditioned and artificially lighted, windowless factory building is the Allison Div of General Motors plant at Speedway, suburb of Indianapolis. The factory, scheduled to go into operation within the next three months, will turn out liquid-cooled engines for U. S. Army aircraft.

The diesel power plant consists of two 16-cyl and two 6-cyl, V-type, 2-cycle units with a total of 3600 hp driving generators having a rated capacity of 2800 kw. Design and construction of the factory was by The Austin Co, Cleveland, Ohio.



Air-conditioning penthouse atop new Allison Div plant. Eight separate conditioning units are in four such penthouses

Worthington 2-stage compressors driven by Ideal Electric synchronous motors



THE OPERATING ENGINEER

George Edwards
Advisory Editor

Practical Aids
Maintenance Hints
Questions — Answers

Published monthly as an integral part of POWER

Plan Your Way OUT OF TROUBLE

By LOU ROWLEY
Associate Editor

It's 10-to-1 that heavier loads and longer working hours will cripple limping power plants unless engineers get smart and do something about it. Sell the boss now before it's too late

ANYBODY WHO GETS around to many industrial power plants knows that in spite of all the topnotchers in the game, too many plants just limp along a couple of jumps ahead of trouble. Sometimes the engineer's to blame—doesn't know his business or just lazy. Mostly, the engineer is all that keeps a pile of junk turning out steam and power, while the boss nurses nickels and acts as if he didn't know there was such a thing as a power house.

In any case, it's the engineer who takes the rap when something goes wrong—because he wasn't smart enough to spot trouble heading his way or because he couldn't sell the boss an "ounce of prevention." The rap may be anything from a juicy bawling-out to a lost job, or maybe real grief if trouble takes the form of an accident with personal injuries or loss of life.

The boss nurses nickels

You don't have to look far to find situations of this kind, all set-up ready to pop. For example, in a certain old industrial plant of medium size, there's a Corliss engine belted to a lineshaft supplying the whole plant. The engine runs, but only by some special kind of mechanical miracle. A crack in the crank disk runs through the pin hole; the loose pin pounds. The crankshaft is cracked. It's only a matter of time when something lets go. Various experts in the ballistics of flying steam-engine parts disagree as to where the pieces will land, but there isn't any question that the whole plant will be shut down.

Hot Generator

An engineer friend tells of inspecting another industrial plant where he found a belt-driven ac generator running so hot he couldn't touch the frame. Load had been piled on the unit until it smoked. Our friend warned against adding even one kilowatt of extra load, and went back to the office to write his report. Before he finished, the machine burned out!

Out in the Middle West, a Corliss, belted to the main lineshaft, slides back and forth an inch and a half every stroke because foundation bolts wore loose in the concrete. The engineer doesn't seem to mind; he used to the motion. He says he can't grout up the holes because the plant only shuts down on Sunday and this doesn't give the grout time to set hard. The consultant who told us the story recommended using sulphur to make a temporary repair, but never went back to see what happened. The engineer may have decided he preferred his sulphur in the hereafter.

Dice loaded against the limping plant

These are just samples—there are plenty of others as bad or worse. There's the plant where lack of maintenance scored a diesel cylinder so badly that they had to shut down for a week. And there's the outfit with four 30-year-old hrt's and no spare capacity, where a bad case of leaking tubes put the whole factory out of commission for

a week while tubes were rolled in. And so it goes.

Why start yelling about this now? Limping plants have been getting by for years, why can't they keep on getting away with it? Well, they can't if business keeps on going places. When new business rolls in, lots of plants will go into high gear. More production means more power and steam and longer working hours. Old equipment will get a heavy pounding and spares will be pulled into service, wiping out the safety factor. What's worse, with 2- or 3-shift operation, 6 or 7 days a week, there won't be those convenient nights and long week ends to patch up troubles. Anyway you look at it, the dice are loaded against the limping power plant, and now's the time for the smart engineer to do something about it.

To begin with, it's not enough to know what to do when hell breaks loose. Lots of us have an idea that thinking fast in an emergency marks a good executive. What's really important is thinking *right*, and most of the guys with big reputations for handling emergencies got that way by figuring out, years ahead, just what they'd do if and when trouble started. They're not quick-witted, just forehanded. Of course, the really valuable man goes a step further; he spots trouble coming and heads it off.

Worst thing about waiting for trouble to catch up with you and then doing something about it is that even though you get the plant running again, you may be sorry later that you did it just

Some sick equipment will die on you in 1940

that way. When production stops dead in its tracks for lack of power, no one thinks about anything but getting back on the line. The order of the day reads "Patch it up and get it running again, pronto!" There's no time to consider whether the repair is the really economical thing to do or whether it's throwing good money after bad.

To get out of the vicious cycle of unexpected breakdown, emergency repair, and more trouble later, means taking time out now to find the weak spots in your plant and deciding what to do about them. Unfortunately, in many plants, weak spots won't be hard to find. For example, there's that overloaded dc generator that almost glows cherry-red in the dark. Somebody added a little load a year ago and got away with it, then added a little more later, and then more yet. Well, it can't go on forever—somewhere that machine has a limit and it will probably reach it at 10:00 AM on your busiest day, just when it will hurt.

Suppose you convince the boss and get an OK on a new generator, do you know what you want? It should be bigger, of course, but how much? Would

You can't just go into the boss' office and play bogey man

this be a good time to start swinging over to ac operation? If you know the answers beforehand, the boss' OK gives you a chance to take a step toward the ideal power plant you'd like to have; if you don't know, you're going to waste the company's money and just postpone your troubles.

And so you check through the plant. How about boiler brickwork? Maybe it's good enough for normal loads, when you've got plenty of time for repairs. It'll be a different story when you start pushing the boilers at high ratings. Maybe now's the time to change to suspended walls or water cooling.

Then there's that Corliss with the cracked cylinder—it may not kill anybody when it lets go, but the boss will beat your ears back when he finds out the plant's down for days or weeks. Looking at it now, before the emergency arises, is it really worth fixing, or would you be better off with a bigger, more efficient modern unit? If you would, which is likely, you've got to sell the idea to the boss while there's time to do something about it, instead of waiting for the breakdown, when all the pressure will be in the direction of patching up and getting power again.

Do you get nervous when the boiler inspector comes around? How much will it hurt it he lops 20 lb off your boiler pressure? Can engines or turbines carry load at reduced throttle pressure? How about the howl from the process departments? When this happens, will you rush out and order a new boiler without thinking first? If you've got to get a boiler anyway, maybe it would pay to get one designed for higher working pressure, so in a couple of years you could add a topping turbine and modernize your plant. Whether topping is the answer or not, you should have a first-class reason for the pressure specified for the new boiler, or you're likely to throw away the first money you've been able to get from the boss in years.

How about little things—sick pumps, sick traps, sick valves and piping? Every insurance man knows that if you have a hundred people down with pneumonia, a certain percentage will die. As sure as death and taxes, some of the sick equipment will die on you in 1940, and it wont' pick the right day to do it. Having spares handy will help, but maybe what's needed is revamping and enlarging the whole system. If that's the case, pound away at the boss until you get the green light.

If your plant is like a lot of others, the switchboard is overloaded and maybe even downright badly arranged. Probably, like Topsy, it "just growed"—a feeder here and another there, more breakers and instruments. Probably you can head off trouble by spending a little money now. Wouldn't it be smarter to spend a little more to get a start on a completely new setup, or to begin rebuilding, section by section, getting rid of cockeyed feeder tieups, switching bottlenecks, under-sized breakers?

How about steam and water lines out to the plant? How about shafting, belting, and power transmission in general? If the management spends a lot of money to step-up production, will you get your share for the all-important power services? You won't unless you know what's needed, and sell the boss ahead of time.

What Does It Add Up To?

So much for the questions and answers. What does it all add up to? Just this: the engineer has got to convince the boss he's skating on thin ice if he tries to make an old junk pile handle heavier loads. Put properly, this is a swell selling argument. Savings in the power plant don't seem to mean much in some industries where power represents only a small part of manufacturing cost. But in almost every industry, power failure means dollars lost, and in some it's just plain catastrophic. This is something the boss understands.

However, you can't just go into the old man's office and play boogey-man. In the long run, it won't get you any thing but more headaches. The smart engineer knows what he wants to do out in the power house, this year, next year, and ten years from now. As far as he can, he's looked into the future and made an intelligent plan of development. He knows what equipment should be replaced; he knows what to

replace it with. He knows when expansion will be necessary and he knows just how it should be done.

With a setup like this in his mind, he doesn't make quick decisions that he's sorry for a month later. When he sells the boss the need for a new boiler, he doesn't get stuck with something that will be obsolete in five years, he gets one that will fit into his scheme for boosting steam pressure and adding modern turbines at some later date. He knows where he's going and he makes everything fit into his plan.

If your power plant is just limping along, whether it's your fault or not, do something about it. It's too late to make a plan when you're digging out of trouble. Start at the beginning—the coal pile. Go straight through the fuel-handling system. Do the same for water circuits, steam circuits, electrical circuits, considering every item of equipment along the way. Is each doing its job? Do the parts work together? Will each be able to swing its job under tougher load conditions? Will changes be necessary? Will you have to add equipment?

The only kind a Scotchman can afford

While you're looking for trouble spots, emergency breeders, keep your eyes open for dollar-wasters, things that aren't economically sound. Build your plan of replacement and improvement with an eye to keeping the plant going reliably and to cutting power costs as well. Sometimes you can kill two birds with one stone—replacements or additions needed to insure continuous operation might just as well help lower the fuel bill.

In some cases, the power engineer may be able to handle this planning job himself. More often, even though he knows the ropes, it will pay to call in an outside consultant who can look at the plant with fresh eyes and who has the *time* to make a thorough study, the only kind that a Scotchman can afford to make.

Last, but not least, don't sit back and put your feet on the desk when you've got a good plan tucked away in a pigeonhole. Nothing stands still, and to be worth anything, a plant has got to be brought up to date regularly.

✦ ✦ ✦

Another Diesel Piston Repair

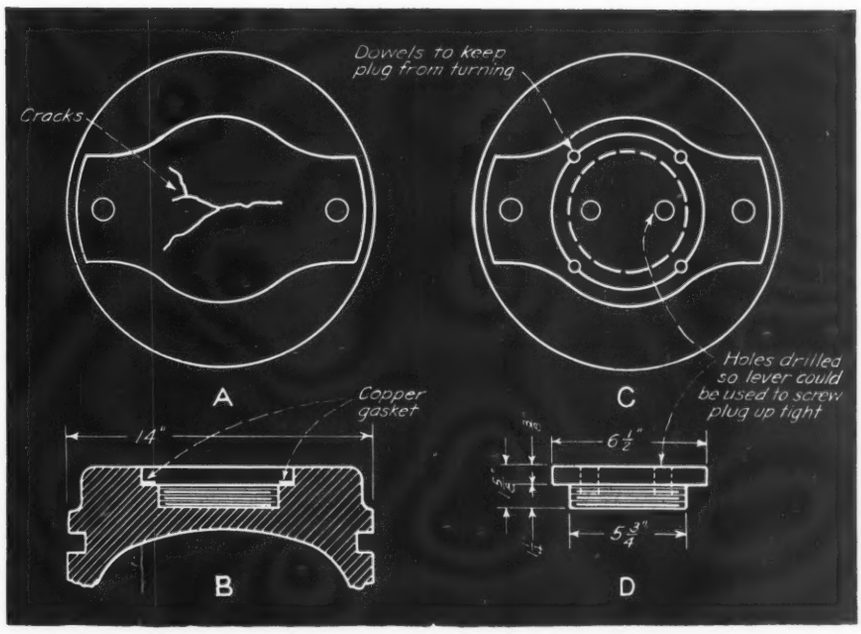
By LESLIE BRADLEY
Dakota Public Service Co

READING Vreeland Tompkins' article in December POWER, on repairing cracked diesel piston tops, reminded me of an experience we had. Our results, with a somewhat similar method, might prove helpful to POWER readers. If I had heard of this way of repairing pistons when ours cracked I wouldn't have been worried about whether the job would stand up or not. Now we know that it does, but then we had our doubts.

When we found one of the pistons of a 240-hp, 4-cyl, 2-cycle engine had burned and cracked across the top, due to faulty ignition, we first tried to repair it by drilling small holes along the cracks, tapping them, and screwing small bolts in about 1½ in. The bolts were overlapped by about half their diameter. The engine wasn't in continuous service, but worked under tough conditions, handling peak loads every day and whenever the high-line got into trouble.

After a few days' operation, the cracks opened up more and allowed gas to enter the crankcase. We had to figure some better way to repair the cracks or get a new piston.

The sketch shows how we repaired this 14-in. piston. The cracks can be seen in *A*, while *B* shows how we bored out the head and threaded the hole. We put a shoulder in the hole for two reasons: to protect the threads from burning, and to make a better seal. We used a copper gasket, as shown (*B*). When the plug was finished, and before screwing into place, we used iron cement generously.



By drilling holes about ½-in. deep into the plug, as shown in *C* and *D*, we got a lever on it for screwing up. Because we weren't sure about the strength of the repair, we put a few dowels around the edge to keep the plug from turning.

Six weeks ago we overhauled this engine and found that the plug looked safe and in fairly good condition. But when we tapped it, it had a hollow sound, as though the plug were loose. We decided to remove it, but after drilling out the dowels we found the plug couldn't be screwed out. We had to drill a series of small holes straight across the plug so that the two halves could be pressed together and then removed. When we got the plug out, it was in good shape and would have run satisfactorily for a long time. It had been in service about 2 years.

How To Line-Up
DUPLEX MACHINES

By H B DIETER

Practical directions for installing new units and curing troubles in existing machines take the mystery out of what looks like a tough job

OPERATING ENGINEERS don't run into the job of lining-up and installing a new engine and compressor every day, but no one knows when he might, or when knowing about it will help in licking operating troubles coming from faulty alignment. Here are practical directions for installing a new unit and pointers on finding and curing alignment troubles in existing machines.

Before jumping into details of the lining-up job, let's see first what we mean by proper alignment. In a common piston engine, the familiar crank mechanism converts reciprocating piston motion to rotary shaft motion. In the usual compressor, the same parts work in reverse. Looking at the skeleton sketch, Fig. 1, where only centerlines are shown, we see that the point where crankpin and connecting-rod centerlines meet describes a circle around the shaft centerline. Common sense tells us that the plane of this circle must be perpendicular to the shaft. Likewise, to work without any unnecessary motion, the connecting-rod centerline should also swing in a plane perpendicular to the shaft. This plane is the same as that containing the circle; we call it *the working plane.*

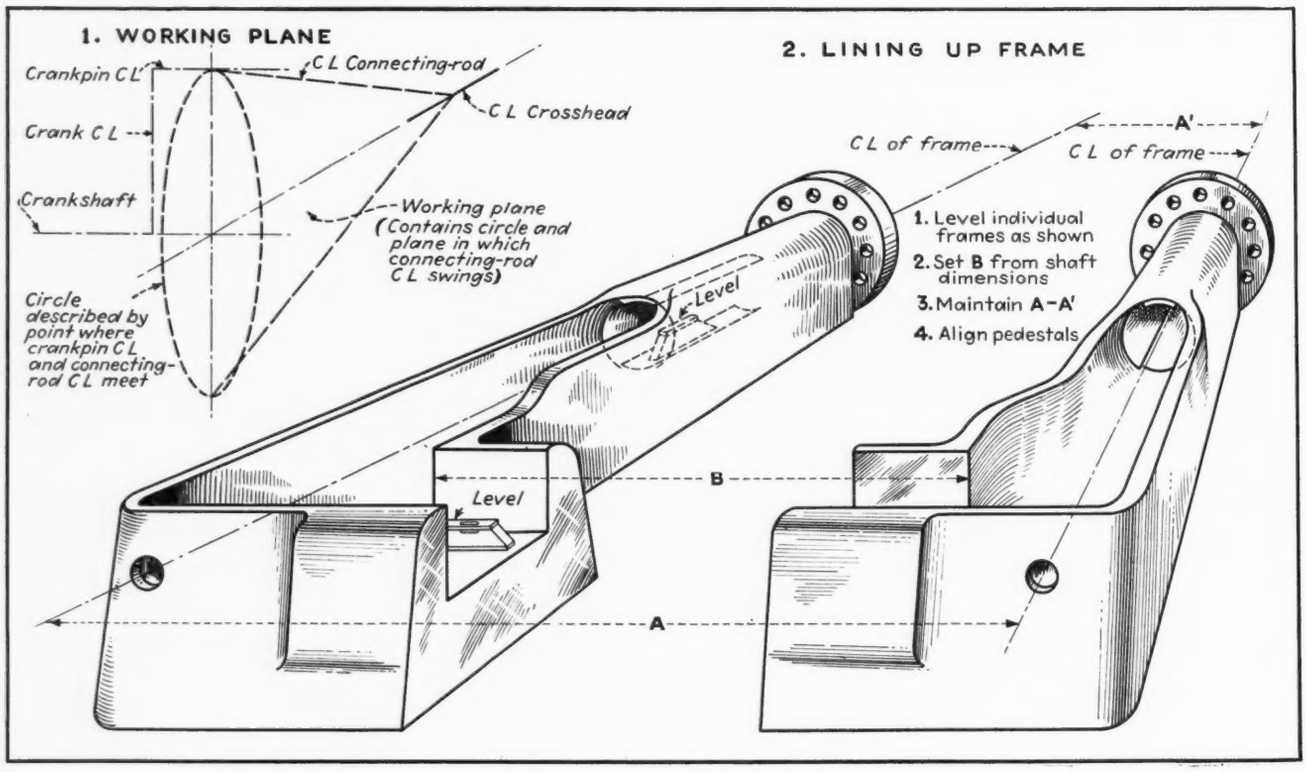
In almost all piston machines, the cylinder centerline meets the shaft centerline, whether the cylinder is horizontal, vertical, or inclined. However, this isn't necessary, and some machines with offset cylinders work satisfactorily.

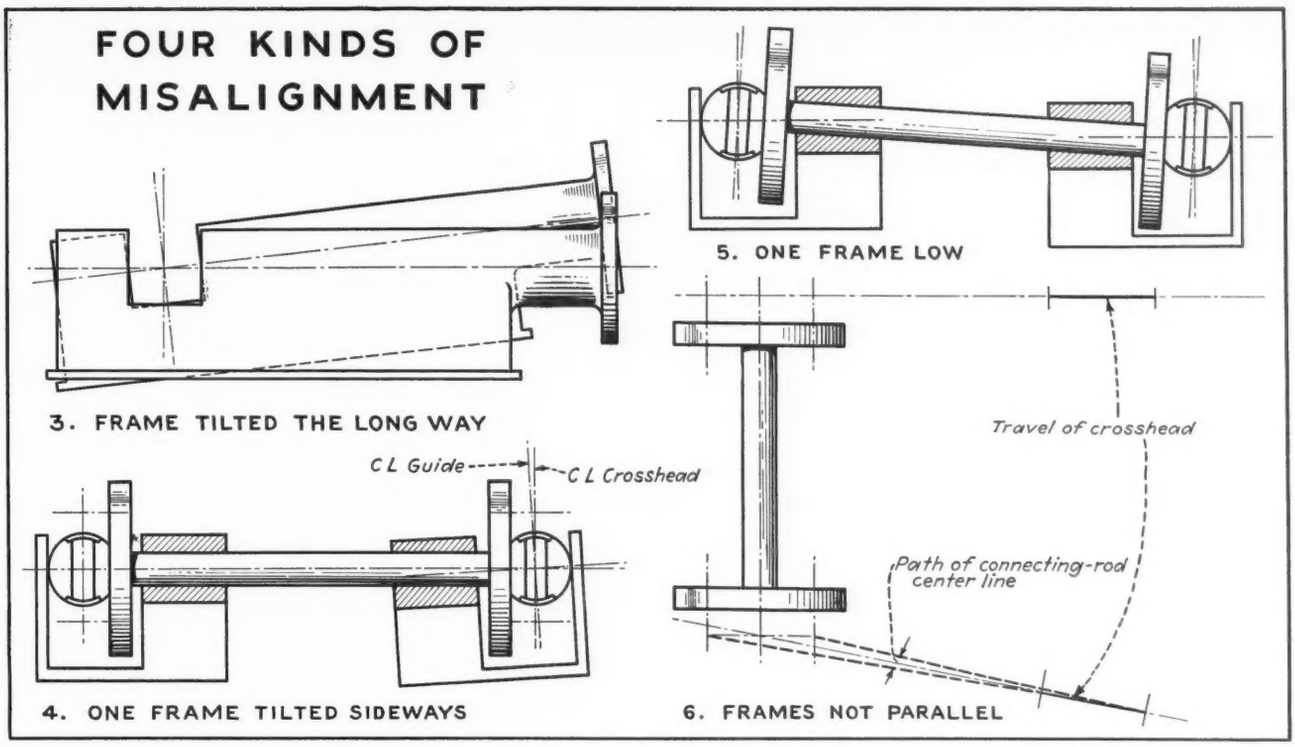
So far, we see that all we need for proper alignment of a piston engine is a working plane perpendicular to the shaft, in which piston, crosshead, and connecting rod must move. This means that in a horizontal machine, we don't particularly care whether or not the shaft or frames are truly horizontal as long as the working parts move in a plane perpendicular to the shaft.

To begin with, in lining-up a new machine, we have to assume that the shopwork of the manufacturer is OK. We start by leveling the individual frames as shown in Fig. 2. Put a level on the crosshead guides to see if the frame is horizontal the long way, and on some machined horizontal surface, such as the pedestals, to check cross-wise. At the same time, see that the frame centerlines are the proper distance apart and parallel, that the shaft centerline is horizontal and perpendicular to centerlines of both frames. After this is done, it's safe to grout the frames. As a matter of fact, it's a good idea to do so, to prevent any shifts in alignment.

Main bearings can now be assembled in the frames and the shaft installed. During installation, check to be sure the shaft comes to rest horizontally and with its centerline perpendicular to the frame centerlines. Although no part of the lining-up job, we have to be sure the shaft comes to a proper bearing. Then we install cylinders. Their centerlines should lie on the frame centerlines, or at least parallel to them.

Assembly of crossheads, pistons, and piston rods follows. Because of clear-




FOUR KINDS OF MISALIGNMENT
3. FRAME TILTED THE LONG WAY
C L Guide
C L Crosshead
4. ONE FRAME TILTED SIDEWAYS
5. ONE FRAME LOW
Travel of crosshead
Path of connecting-rod center line
6. FRAMES NOT PARALLEL

ance between piston and cylinder, the piston-rod centerline won't match that of frame and cylinder. It must, however, parallel both at operating temperature. Connecting rods will normally "fall into place" if they have been previously squared and fitted on arbors of proper size. Assembly of the rest of the machine involves no alignment problems.

Sometimes we find an old machine pitches toward or away from the shaft, Fig. 3. The only way to fix this would be to remove grout, re-align, and re-grout. Before spending a lot of time and money, let's see whether we need to. Back at the beginning we saw that the one thing necessary to correct alignment was a working plane perpendicular to the shaft, with the connecting rod swinging in this plane. In most cases of pitched machines, the working plane won't be disturbed and there is no real need to re-align.

However, it's a good idea to check if the cylinder has the same pitch as the frame, and if it hasn't, to see whether re-aligning the cylinder will affect the line-up of the other parts. Luckily, this can be checked without dismantling the machine. If the piston rod, on outer dead center, parallels the guides, and if it "rides straight," the pitch of the cylinder must be right. If the rod parallels the guides at outer dead center, but appears to "ride up and down" in the packing, the cylinder pitches wrong and packing trouble, leaks, and a hot rod are likely to follow. If any of these troubles pop up, the operator must decide whether the cylinder should be re-aligned to the frame or whether frame and cylinder should be made horizontal again. Usually the first would be cheaper.

One Frame Tilted

If one frame of an engine with flat guides tilts sideways, there will be trouble, as the crosshead cannot adjust itself. However, this won't affect the alignment of an engine with bored guides as long as the shaft stays perpendicular to the lengthwise centerlines of the frames and beds properly in the main bearings (Fig. 4). We can see that the crosshead can shift to work perpendicular to the shaft and since the working plane isn't disturbed, no re-alignment is needed. Of course, the tilt gives the main bearing an odd shape, and more scraping will be required to fit a new bearing on this side. The labor saved by not re-aligning the whole machine will pay for a lot of extra labor in replacing bearings, however.

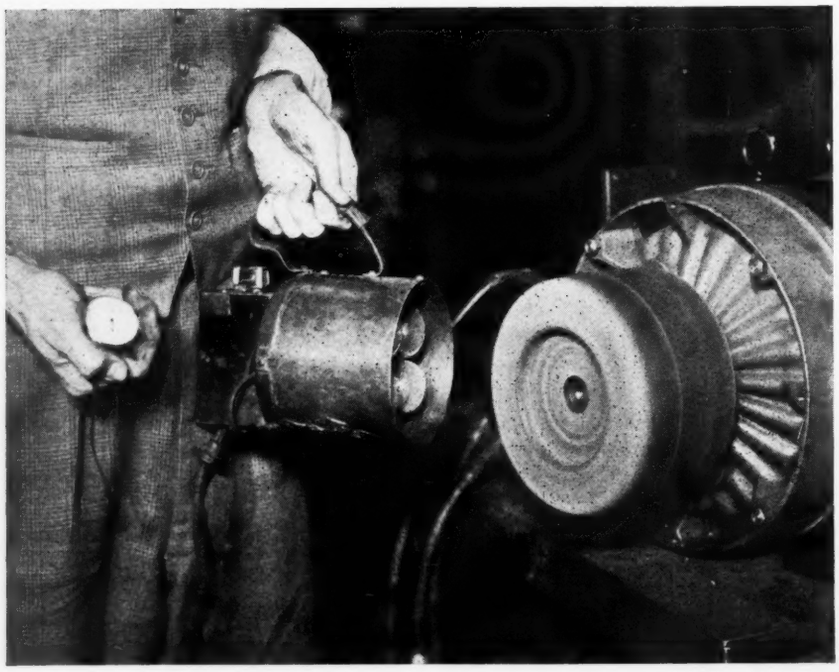
Fig. 5 shows another common case of misalignment; one frame has settled below the other. Here again, there's no need to do a complete job of lining-up. The crosshead guides, of the bored type, shift slightly and the working planes stay perpendicular to the shaft, even though it is no longer horizontal. Of course, the shaft will thrust toward the lower bearing, but this is usually negligible. However, there will be the same trouble as before with scraping and replacing bearings. In most cases, this kind of misalignment can be corrected by shimming under the lower bearing, without changing position of the frames.

So far we've looked at engines out of line in such a way that the working plane wasn't affected or was free to shift. Fig. 6 shows another case, where unparallel frames force the connecting rod to move in three dimensions, the connecting rod thrusts sideways on the crosshead making operation noisy and wear rapid. If one side of a duplex machine always shows crankpin and crosshead trouble, check for this condition. If you find it, however, there isn't any simple remedy. Short of doing a complete job of lining-up, the only thing is to try to "split" the difference, by "throwing" the shaft in the right direction. This may work enough improvement to avoid full re-alignment.

A shaft not square with the frames, even though the latter are parallel to each other, doubles the trouble. Luckily, the remedy lies in simply "throwing" the shaft by shimming and scraping.

Final pointer: out-of-line frames will not affect the operation of properly fitted and maintained main bearings. Of course, a change in alignment after fitting will certainly cause trouble. Only misalignments that prevent the rods from swinging in the working plane affect the other bearings. Doing a complete job of lining-up is indicated as a remedy for bearing trouble only when vertical planes through frame centers are not parallel. Incidentally, a common cause of misalignment is uneven wear, particularly in main bearings. Operating engineers know the answer to that.

PRACTICAL AIDS IN OPERATION



Neon Lamps Check AC Motor Speed

FOR OBTAINING SPEED of alternating-current machinery, we devised a simple portable unit which it is as easy to apply in the field as in the shop. Four clear-bulb, 3-watt neon glow lamps are used in a group, as in the photo. Four lamps are necessary because each is good for 115 volts and to use them directly on the motor circuit requires operation on 220 and 440 volts.

Four standard lamp bases are mounted on a small board. A conical steel-plate hood, painted black inside, keeps out other light rays. On the back of this board is mounted a 3-pole, 2-way switch. Thrown in one direction, this switch connects the lamps in two groups of two in series for 220 volts; thrown in the opposite direction, the switch connects all lamps in series for 440-volt operation.

When light from the neon lamps is directed onto the end of a running induction-motor shaft, the keyway will appear to revolve slowly. The number of revolutions per minute apparently made by the shaft is what is known as slip speed. This speed subtracted from the synchronous speed, taken or estimated from the motor name plate, gives the actual speed at which the motor is running.

We have found checking motor-slip-speeds with neon lamps more accurate than a tachometer because calibration is never required, and more convenient to use. Slip-speed of any ac motor can be obtained with neon lamps, except motors operating at more than 100-rpm slip. Marking the end of the shaft with a single chalk mark simplifies counting and using a stop watch increases accuracy of the time interval. Subtracting slip rpm from synchronous speed gives motor operating speed.

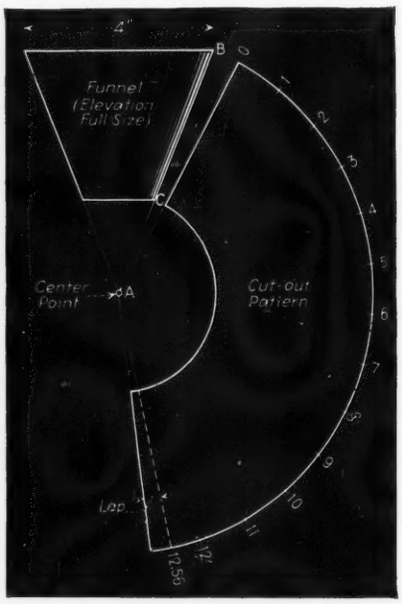
In a plant where all alternating current comes from the same source of controlled frequency, a single neon lamp and standard reflector, which can be plugged into the nearest 115-volt receptacle, is all that is needed.

Cleveland, Ohio D M CHARLES
The Reliance Electric & Engrg Co

How to Lay Out a Funnel

AS A POWER-PLANT OPERATING ENGINEER, I occasionally have to make funnels for filling cans, catching overflows, etc.

To get the cut-out pattern, make an accurate full-size elevation drawing of the funnel, as shown. Extend the sides down until they meet at the center point *A*. Using this center, draw two



arcs, one from top edge of funnel, one from bottom edge.

Measure top diameter of funnel and multiply by 3.14 to get length of top edge and lay this distance out along the outer arc.

For example, if funnel diameter is 4 in., circumference is $4 \times 3.14 = 12.56$ in. Set dividers for 1-in. steps, lay off this distance and lay off desired lap as shown. Paste pattern on sheet metal and trim to solid line. Then wash off pattern, and roll metal to shape, ready for fastening.

Often the whole construction can be conveniently made directly on the sheet metal with dividers, making a paper pattern unnecessary.

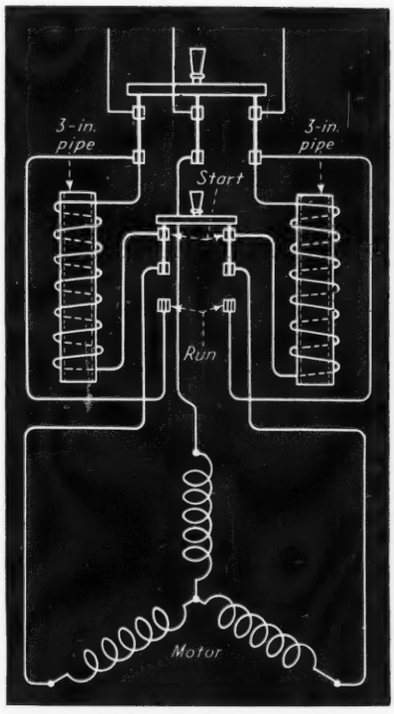
In other cases it will be most con-

venient to draw the funnel elevation alone on paper. From this drawing, set dividers first to *AB*, then to *AC*, for scribing the two arcs on the metal. Spot center on metal sheet with an eye to avoiding waste in trimming.

Saltville, Va. J C PORTER

Temporary Starter for AC Motor

ONE OF OUR COMPENSATORS for starting a 10-hp, 220-volt, squirrel-cage, induction motor burned out. Another was not available until the repair could be made, so we solved the problem by winding 30 turns of No. 6 insulated wire on each of two pieces of 3-in. iron pipe and connecting them to a 2-pole double throw switch, see diagram. Closing the switch connects the coils in circuit for starting. With the switch closed down, the motor is connected directly to line. The arrangement worked satisfactorily until we could rewind the compensator.



Plainfield, N. J. H W HODGSON

Sledge-Hammers Voltage Into DC Generator

USING A SLEDGE HAMMER on a direct-current generator cannot be recommended as a steady diet, but it sometimes produces results in an emergency. An armature from a marine generator had been rewound in a shop and put back into place. When started, the machine failed to generate and I was sent out to find out why. We checked all connections and found them correct so decided that weak residual magnetism in the pole pieces caused the trouble.

A current supply was not available to separately excite the field coils, so we decided to try striking the field frame with a sledge hammer after the machine was running at full speed. Two whacks with the hammer started the voltage on its way up, but the brushes began to spark and the generator went dead again. We found the brush-holders short circuited on the yoke and when this was cleared, we again tried the hammer, with complete success this time.

Now, just what did the hammer do? Residual magnetism in the field poles was not sufficient to start the voltage building up from the very small current caused to flow in the field coils by

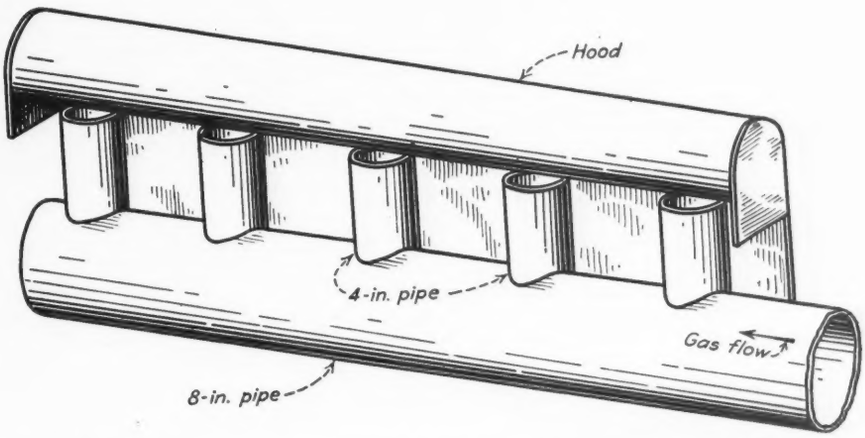
Homemade Muffler Reduces Engine-Exhaust Noise

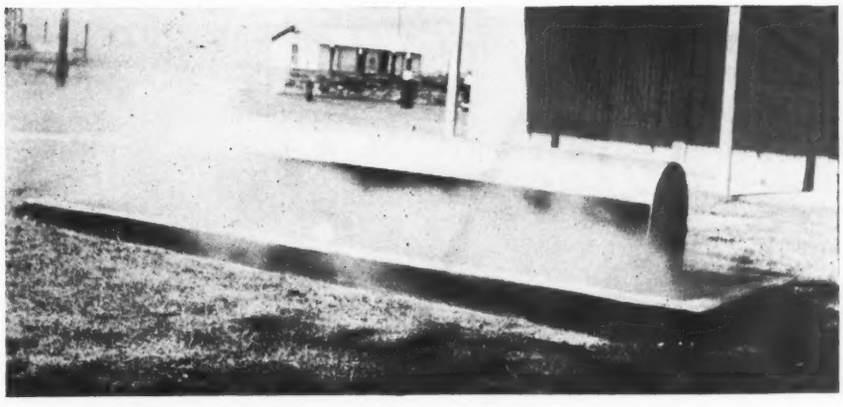
MUFFLING of internal-combustion-engine exhaust noises is frequently passed on to the operating engineer by the erecting gang. We solved this problem on two 150-hp 2-cylinder gas engines, without creating objectionable backpressure or requiring an elaborate outlay. We cut off the 8-in. underground exhaust line, where a 45-deg surface pipe was welded to it, and extended the line into a small concrete sump pit, see photo, with provision for carrying away any condensation that might occur.

We blanked off the end of the 8-in. pipe and welded five 4-in. stub pipes into its upper surface, as in the drawing. A semi-cylindrical hood, formed from splitting a piece of 8-in. pipe, was then supported over these stubs by a plate welded along one side of the pipe, with two stiffener plates at the ends.

Now an exhaust impulse travelling along the 8-in. pipe, loses part of its gases at each succeeding upright stub, is then turned through 90 deg and comes from under the curved edge of the hood in a downward direction, in what amounts practically to a steady flow of exhaust gas. This action has eliminated the objectional bark of the engines. Any cooling water piped to the exhaust is carried through the stubs, and is likewise directed downward into the pit, instead of being blown broadcast over the landscape.

Longview, Texas M T PATE





the weak voltage generated. Hitting the field frame with the hammer caused the iron molecules to vibrate so that the iron was more easily magnetized. It did not require very much to start the voltage building up; once started, it came on up in a normal manner.

Trenton, N. J. R O CUMMINS

Eccentric Pulley Causes Commutator Trouble

A DIRECT-CURRENT GENERATOR, belt-driven from a steam engine, had an acute attack of eccentric commutator wear. About every two months the armature had to be removed for truing the commutator in a lathe. A new armature was purchased and installed, but its commutator would also wear out-of-round and required frequent truing.

The trouble was finally traced to the pulley on the armature shaft being out of round, because its hub had been drilled off center. A new pulley cured the commutator trouble.

Plainfield, N. J. H W HODGSON

Miter Box for Pipe

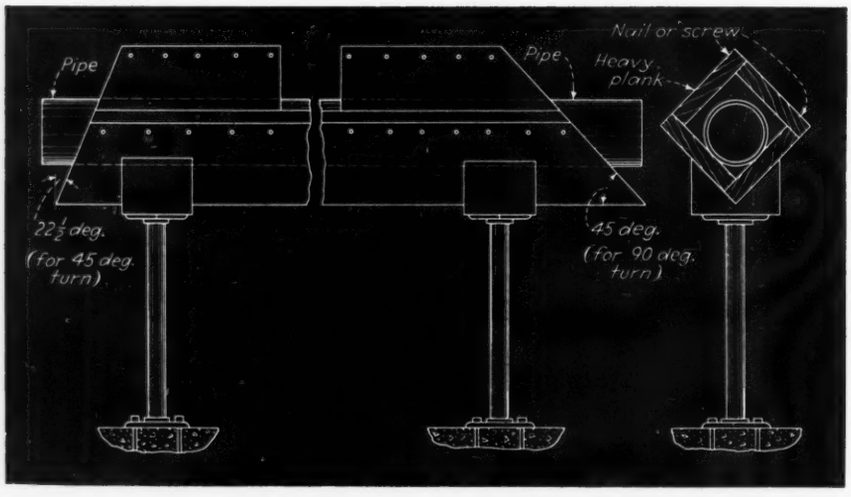
WHERE PIPING must be cut true 45 deg or 22½ deg (for welding 90-deg or 45-deg joints respectively), a variety of jigs and templates can be used to mark pipe for flame cutting. If straight lengths can be handled in the pipe shop, the permanent fixture here shown is hard to beat for speed, convenience and accuracy. It requires no adjustment for pipe size. In most cases, it is not even necessary to clamp the pipe in place.

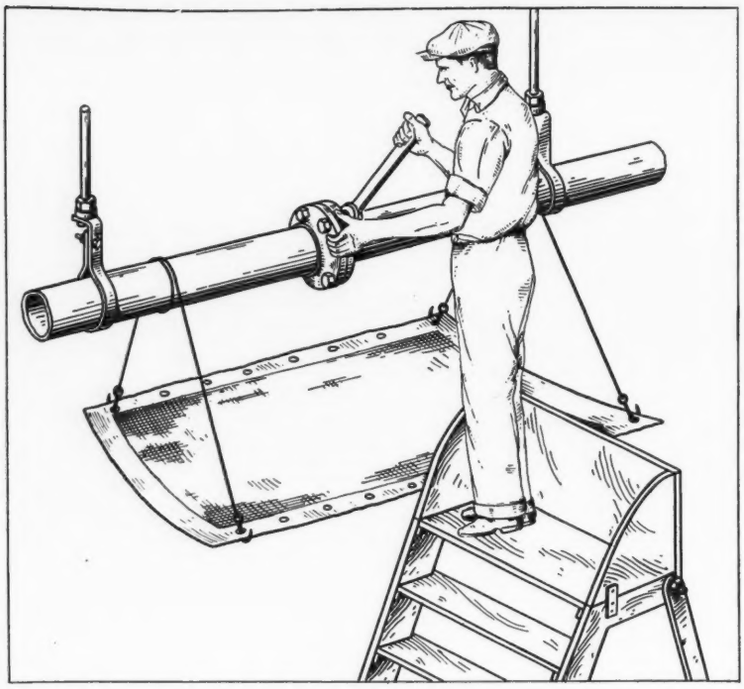
Pick up any size pipe up to the capacity of the fixture, shove it through the trough until end projects slightly beyond the desired miter. Generally, weight of the pipe will be sufficient to hold it motionless in the vee while the miter is lightly marked with a wide-blade saw (new hack saw) held against the miter surface with one hand and pushed around with the other.

A metal-cutting backless handsaw, with a blade at least 4 in. wide, would be ideal, but it may not be obtainable. In that case, a cheap or discarded wood saw will do the trick if the mechanic can overcome his natural prejudice against such manhandling of a wood-working tool. The teeth will start dulling immediately but they will serve well enough for making a good many markings.

Dimensions may be varied to suit the usual run of work. A box of 2 in. x 10-in. planks will accommodate any pipe up to 6 in. and will stand a lot of slinging. The box may, of course, be mounted on the back of a pipe bench instead of on pipe stands as shown in the figure.

Philadelphia, Pa. B A BRIGGS





Nets Make Overhead Working Safe

WHEN MEN WORK OVERHEAD, there is always danger of tools falling on some one or onto machinery below. In our plant, we use tool nets to prevent such accidents. Nets are made of closely woven heavy-duty fish net, fitted with a canvas border, flat metal stiffeners and large eyelets. These are hung by lines or laid below where work is being done, as in the figure and they have proved to be a real safety device.

Penacock, N. H. C H WILEY

AC Generator Hunting Corrected

TO MAKE two alternating-current generators operate in parallel is sometimes quite a trick. Several things can happen to give trouble, as the following experiences show.

In one plant, a corliss-engine-driven alternator had been in service for three years and another similar unit for three months, when the engineer connected them in parallel. The units soon started to hunt so badly that they had to be shut down. Replacing the wearing edges on the hook blocks at the ends

of the bell crank and dashpot arms of the older engine corrected the trouble.

A 2000-kw turbine driving an alternator gave trouble from hunting under light loads at night, but operated OK during the day when the load was heavy. This trouble was corrected by easing up on the governor spring. In another plant, two 3000-kw turbine-alternators would hunt after being paralleled. After the incoming machine was on the line, the operator would adjust the governor to make it take part of the load. One day the engineer suggested that part of the load division be made by adjusting the governor of the loaded machine, then by adjusting the governor on the incoming machine to correct the frequency. This change stopped the hunting. It may be difficult to explain how some of the changes stopped the generators from hunting, but they did the trick.

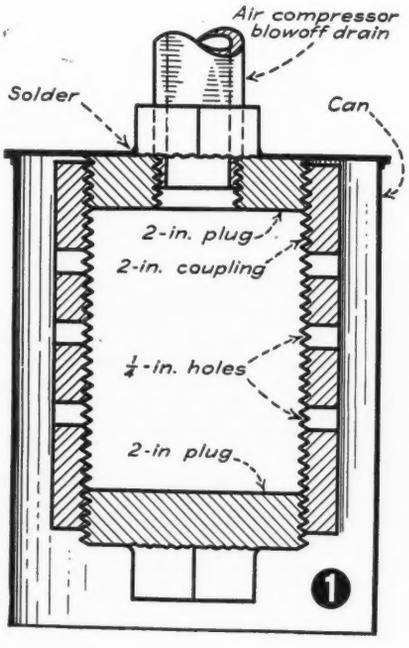
Nutley, N. J. THOMAS SHEEHAN

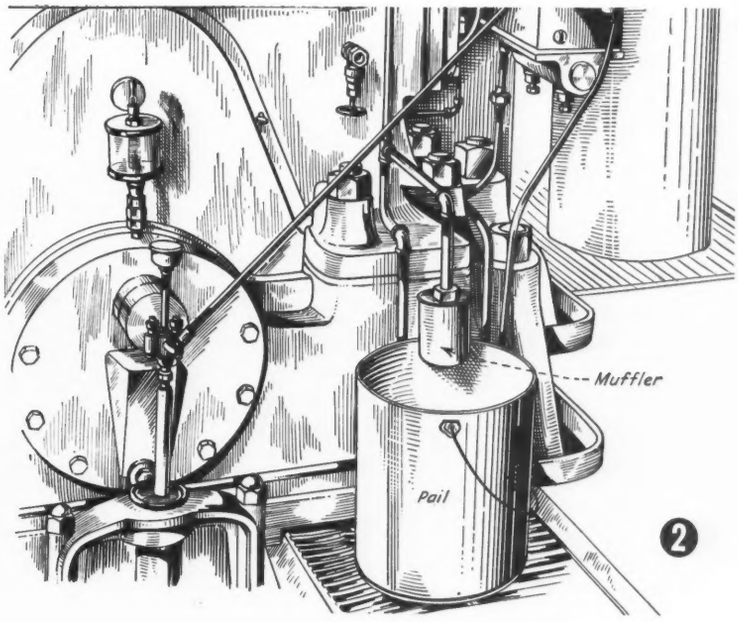
Tin-Can Muffler for Air Receiver

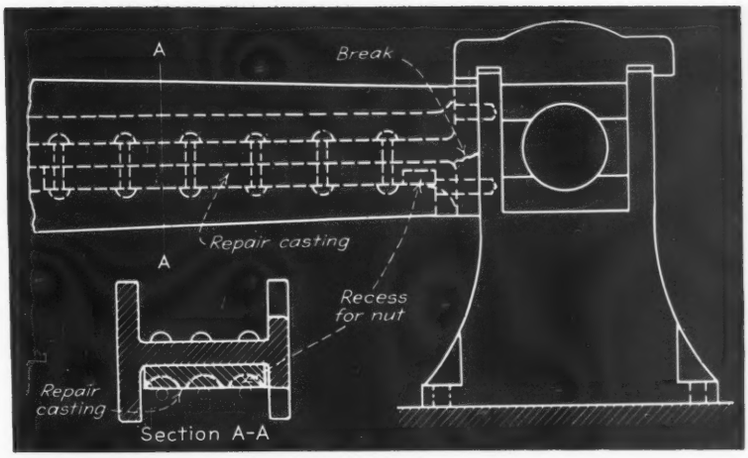
WHEN WE BLEW DOWN the air compressor, cooler, and air bottle on our diesels, the floor always got baptized with a heavy slug of oil which just couldn't be caught in a pail. So we made a muffler for the blowoff drain pipe, using a 2-in. pipe coupling, 2 plugs, and a tin can, Fig. 1. We pipe-tapped a hole in one plug to take the blowoff pipe, and drilled ¼-in. holes in the sides of the coupling. Coupling and plugs were assembled as shown. Then we took a common garden-variety tin can, cut a hole in the bottom to fit the nut of the upper plug, cut the top off clean, and soldered it on the upper plug. Fig. 2 shows the muffler installed.

Now when we blowdown, the oil spatters through the holes in the coupling, comes up against the sides of the can, and drips down into the pail. This rig saves plenty of floor cleaning and paid for itself many times over in rags alone. When the muffler was installed the can was painted to match the color of the engine.

Fernandina, Fla. A B ALLEN







Engine Frame Repaired With Flanged Casting

ON THE HIGH-PRESSURE SIDE of our cross-compound engine, the main pillow-block worked loose on its foundation and could not be tightened without shutting down. The engine had to be kept running 24 hours a day and frequently for 7 days a week. The engine was of an early vintage and of rugged girder-frame construction.

Our engineer believed that the bearing was causing heavy stresses in the flanges connecting the frame and bearing, and watched them closely. One day the under flange cracked off and the engine had to be shut down. Only the vigilance of the engineer prevented a serious wreck of the engine and other damage to the plant.

The engine was repaired with a heavy steel casting riveted to the under side of the frame, as in the figure. This casting was flanged to fit the broken one and recessed to permit using the bolts in their original holes. While the repair was being made, we secured the bearing pedestal to the foundation and no further trouble developed.

Butte, Mont. C O HAGEN

READERS' PROBLEMS

Questions for Our Readers

Oil-Tank Heater

Question 1

PERHAPS *some* POWER *readers can offer suggestions on making and installing a temporary steam heater for our fuel-oil storage tank. In our setup, a duplex pump, connected close to the 50,000-gal. tank, forces oil 375 ft to the powerhouse supply tank, which is elevated 24 ft. When the storage tank was built there were steam coils in the bottom and we had no trouble pumping this distance. However, someone was careless about draining and blowing out these lines in winter months and they were damaged and are now useless. With cold oil, we have pumping trouble.*

Recently, I made a heater of ¾-in. pipe coil, 14-in. dia, containing 26 ft of pipe. This was lowered into the tank directly in front of the pump suction, through a 16 x 16-in. opening in the roof. I am not getting results from this heater arrangement, as the warm oil rises to the top, leaving the heavy, cold oil at the suction opening.—MM

More "Mileage" from Diesel Lube Oil

Question 2

WE ONLY GET *about a 1000 rated bhphr per gal. of lubricating oil on our 450-hp diesel. Will a wiper ring on the skirt and another replacing the lowest of the four rings on the crown improve this performance? What other steps could we take to get more "mileage" out of lube oil?*—CCD

SUITABLE answers from readers will be paid for if space is available for publication. Answers accompanied by practical drawings or photographs will command additional pay.

George Edwards Summarizes

AT LOW ENGINE LOADS, according to J I Clower, in "Lubricants and Lubrication", lower-viscosity oils should be used, with relatively high percentages of compounding—large enough to form a ready and persistent emulsion. Clower recommends a non-filtered oil of 8 to 12% compounding, flash point of 485 F, fire point of 545 F, and Saybolt Universal viscosity of 90 to 100 sec at 210 F. This compounded oil should be fed in as small amounts as possible.

A separator, providing it is large enough, drained through a trap and cleaned regularly, will remove oil particles in suspension in the exhaust. Emulsified oil must be filtered out, and may have to be taken out by adding alumina-soda or similar chemicals. This, however, should cut oil content to ½ part per million or less. But even Mr Clower admits that the problem's no picnic, and maybe the oil company's expert is the final answer in any specific case such as the one bothering FSP—GEORGE EDWARDS.

Lubricating Steam Engine

Answers to Dec Question 1

The Question

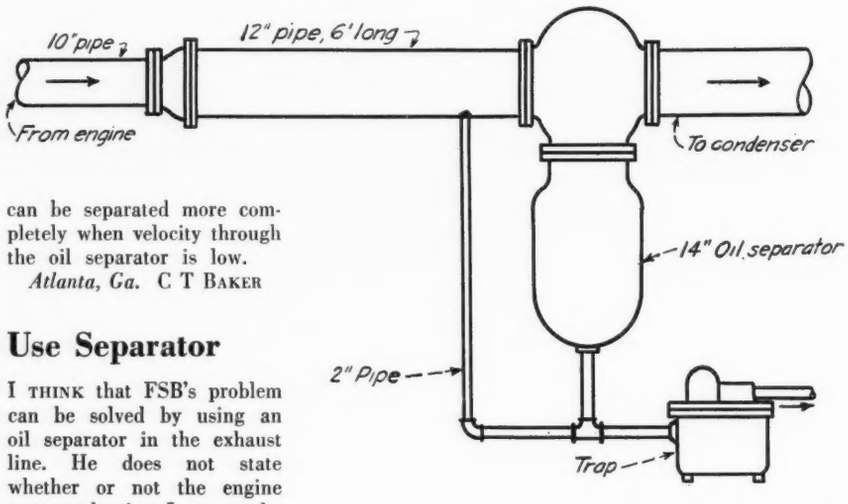
WHEN OPERATING *a steam engine fully loaded, a mineral oil gives best results and can be easily separated from the exhaust. At light loads, condensing steam tends to wash oil off the cylinder walls. Under these conditions, a compounded oil seems to work better, but it is harder to separate since part emulsifies. Can* POWER *readers tell me the best compromise solutions for engines working at variable loadings, and where oil in boilers is to be avoided?*—FSP

Reduce Exhaust Velocity

THERE ARE SITUATIONS in which a compounded oil will do a much better job of lubricating the steam cylinder than a straight mineral oil. It is also quite true that compounded oils are more difficult to separate from the exhaust.

In the case of a tandem-compound condensing engine, this trouble was solved recently by substituting a 14-in. separator for the 10-in. separator originally installed and by adding a 12-in.-diameter section of pipe between the engine and oil separator. This reduced the exhaust velocity at the entrance of the oil separator, below that of the regular exhaust pipe. Both separator and velocity-reducing fill piece were drained by a reliable trap. The sketch shows the set-up. This scheme works because either mineral or compounded oil can be separated more completely when velocity through the oil separator is low.

Atlanta, Ga. C T BAKER



Use Separator

I THINK that FSB's problem can be solved by using an oil separator in the exhaust line. He does not state whether or not the engine runs condensing. I assume the engine exhausts through an open heater to atmosphere and the oil gets into the boilers by way of the feedwater heater.

I think that the compounded oil will give best results if it is compounded for the steam pressure and conditions at his plant. Generally speaking, a compounded oil will give better all-around results. The degree of compounding must be arrived at only after careful study. Most of the large oil companies cooperate fully in this respect and will recommend an oil after studying conditions.

If the plant runs condensing (surface or jet), the problem presents other difficulties. Among them would be suitable storage capacity to allow the oil to separate before it is used in the boiler.

Springfield, N. Y. JOS O'BRIEN

Recommends Mineral Oil

SINCE OIL IN BOILERS should always be avoided, a compounded oil is not recommended when condensate goes back to the boiler. However, a small amount of compounding improves the adhesive quality and may be used, in some cases, with complete satisfaction. A reputable oil company should prepare the oil, preferably on an individual basis.

Oil lubrication is not essential in the cylinder with saturated steam, so it seems to me that FSP will achieve satisfactory operation by using a straight mineral oil at all times. A piston-rod swab should be applied and kept well filled with mineral oil to protect the rod and packing on long light-load runs. The steam line must be

well drained and well insulated. Also check cylinder lagging and, if found defective or inadequate, repair accordingly.

Toledo, Ohio LAWRENCE KISKA

Keeping the Charge in Pump Air Chamber

Answers to Dec Question 2

The Question

THE TENANTS IN OUR BUILDING *complain of hammering and jarring in the house-service-water lines, served by a duplex steam pump. The pump is fitted with an air chamber, but it seems to lose its charge. What is the remedy?*—JGW

Use Snifting Valve

IF HAMMERING in the water lines can be eliminated by charging the air chamber, a snifting valve in the pump suction is recommended. This is simply a check valve with an adjustable opening to regulate the air admitted on each suction stroke. In case suction pressure is above atmospheric, a small motor-driven compressor can be arranged to serve air at constant pressure to the snifting valve.

I suggest that JGW check the plunger rods for lost motion in plungers and crossheads. A loose fit at these points will cause water hammer.

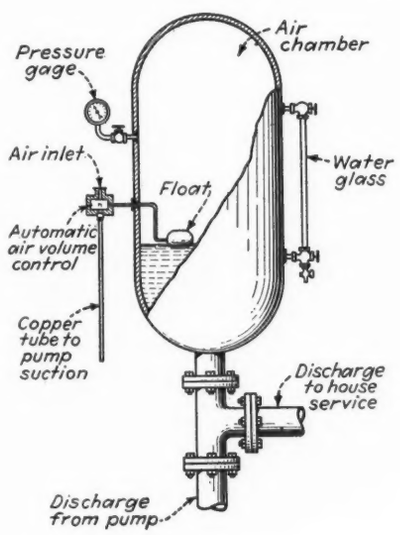
Washington, D. C. J A ALGER, JR

Look For A Leak

CORRECT DESIGN requires that the volume of the air chamber be at least 4 times pump displacement. It is assumed that water hammer does not occur when the chamber is well filled with air. Water which has been exposed to atmosphere generally carries 2% or more of air in solution and it is unusual that there should be any difficulty in holding a charge of air unless there is a leak or the discharge line from the pump is faulty and prevents trapping air. A soapsuds test will show if any air is leaking from the chamber. A tee connection, without reduction in pipe size, from pump to chamber, will effectively trap air entrained in the water.

There are several ways to make up air loss. When there is a suction lift a small valve may be connected to the suction line to draw air into the pump. The sketch shows a float-controlled air valve which automatically admits air to the pump when the chamber begins to lose its charge. If the suction line is under pressure, an air supply from an outside source is necessary, such as a compressor or a trap. (Ed. Note —See sketch in Gibbons answer).

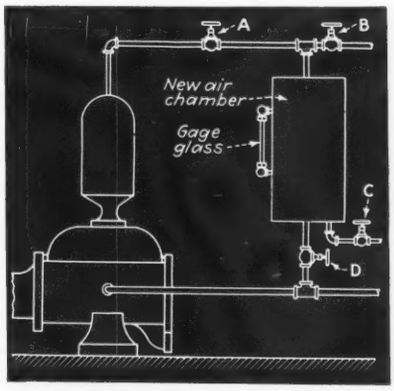
Fresno, Calif. E H CARLSON



Two Chambers Work Together

JGW DOES NOT GIVE full particulars of his system, but apparently things are fairly satisfactory when the air chamber has a full charge of air. At the same time, it is likely that increased capacity would do no harm. The sketch shows how to do this and take care of the re-charging as well.

The set-up operates as follows: with valves *A* and *D* closed and *B* and *C* open, the new chamber fills with air; with valves *B* and *C* closed and *A* and *D* open, air and



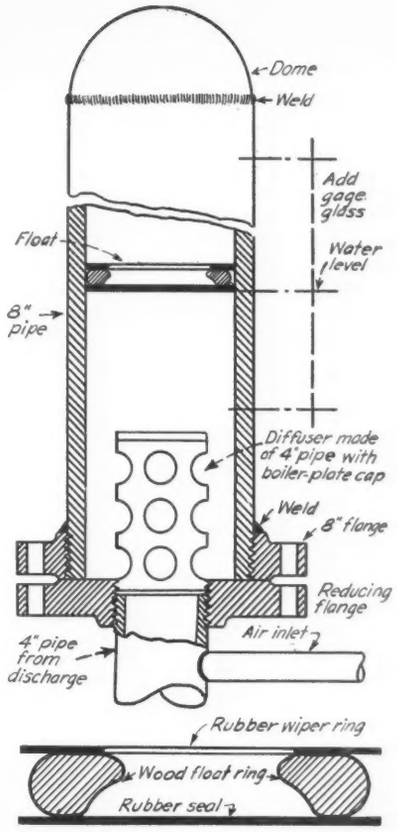
water tend to equalize in both chambers and they operate as one, with plenty of air and increased capacity. With valve *A* closed, chambers will operate independently. Valves *A* and *D* may be closed when operating and the new chamber used only for charging the pump chamber with air.

Bloomfield, N. J. J O G GIBBONS

Put Diaphragm in Air Chamber

JGW SAYS THE AIR CHAMBER "seems to lose" its charge. It *does* lose its charge by absorption into the water in the chamber. The rate of absorption depends on a number of things, the most important being diameter of opening between chamber and pump-discharge line, volume of water handled, and range of peak pressures compared to average or "line" pressures as shown by the gage.

The duplex pump, if of normal design and in better than average condition, may be expected to create peak pressures between various points of the overlapping



Detail of Float

strokes amounting to as much as 150% of the operating pressure. This surge tends to compress the air in the chamber along a range of values approximating those computed by applying Boyle's Law, assuming constant temperature conditions during the alternating pressure cycles. That is, assuming an operating pressure of 100 lb (abs), the air space in the chamber will be reduced one-third at each peak, if lag in the system is not considered. In practice, for such a pressure range, the liquid-air contact surface will vary in elevation from 4 to 6 in. with each surge; not as a smooth plane, but as a series of jagged peaks and depressions offering many times the normal area for absorption.

To reduce the absorption area, the writer, working with Mr Elton Sterrett, assistant chief engineer for an oil pipeline company, experimented with a number of types of diaphragms between liquid and air-chamber charge, with a view to reducing the number of charges needed or the frequency of checking. An ordinary wooden float, riding the top of the liquid column in the chamber, suffers rapid deterioration, and either swells and jams or splinters under the surge impact. After trying a number of schemes, the diaphragm shown in the sketch was worked out, and has been giving good service on medium to high-pressure oil lines (350-650 lb manifold pressure) with a minimum of replacements.

A wooden float ring, made of two flat sections of straight-grained white pine, glued together with grain of each at 90 deg to the other, provide the required buoyancy. The ring is turned to a cross-section like that shown. The upper or flat surface carries a rubber ring cut to fit

closely to the air chamber bore, and 2 in. wide. The bottom face of the diaphragm is closed with a rubber disk, also cut to chamber diameter; copper rivets fasten gaskets and wooden float ring together.

To work with the float, the air chamber was redesigned, with the chamber proper made of 8-in. pipe, capped with a welded dome cover, and carrying the usual sight-glass along one side. The chamber was welded to a standard 8-in. pipe flange, which mated with the reducing flange carried on the 4-in. riser from the pump discharge main. Into the upper face of the reducing flange we welded a 6-in.-high diffuser of 4-in. pipe, the top of the diffuser being closed with a boiler-plate disk. The sides were perforated with 1-in. holes, drilled as close as possible without weakening the metal too much. To install or replace a diaphragm, the chamber is opened at the flange, the new float centered over the diffuser, and the chamber slipped down over it to be re-bolted in place.

To remove a frequent source of air loss, the air charging line taps into the 4-in. riser below the flanges. Air under pressure admitted at this point will immediately rise to the chamber although a portion may be trapped under the diaphragm. Any trapped air will work free after a few pump strokes, leaving the lower side of the float in direct contact with the liquid.

Theoretically, the float, with an area of 48.7 sq in., blanks off all but 2.4 sq in. of the 51.1 sq in. area of the chamber, and thus limits absorption to about 4% of that expected with free contact between air and liquid. In terms of recharging, intervals between recharges should be 25 times longer with the float than without. In practice, the periods average 15 to 20 times longer.

The flexible diaphragm on the float is needed because of the speed with which the pressure rise travels. Even a light float has a slight inertia lag and this, with a plain float, would produce severe pounding and excessive jetting of fluid around the edges. With the diaphragm, however, the give in the rubber takes up some of the initial surge, which, in earlier and unrelieved ring forms, quickly cut away at the point of contact.

The diffuser at the bottom of the chamber prevents the sudden pressure rise from carrying a slug of water, roughly 4-in. in diameter, through the center of the motionless liquid in the chamber, to strike the center of the float severe blows. The diffuser also acts as a stop for the float in case of drainage of the chamber, in which case the air or fluid trapped above the float bypasses around the flexible rubber edges of the float, without causing damage or washing material into the line.

Kilgore, Texas C C LYNDE

Check Piping System

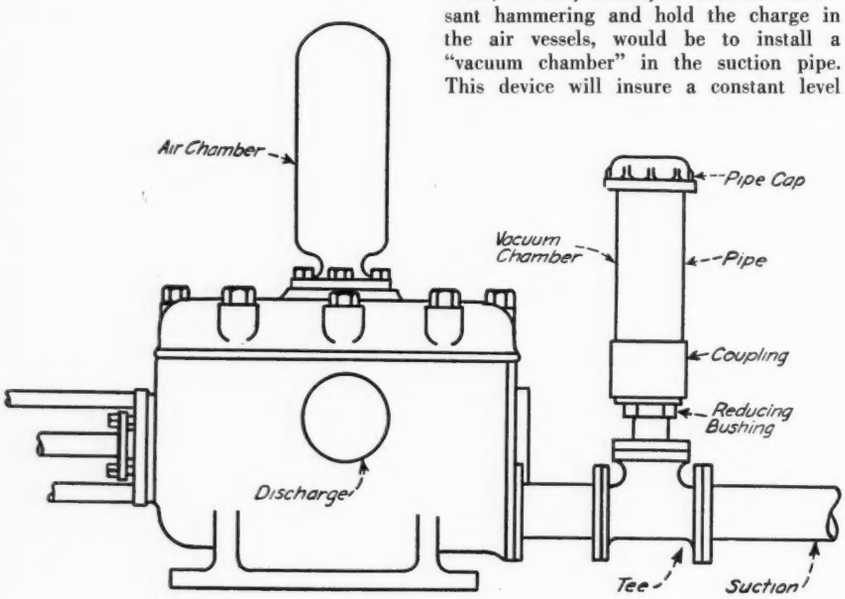
I FIND IT HARD TO BELIEVE that JGW's pump is in any way to blame for the hammering. If loss of air cushion caused the noises, pulsations of each stroke would travel uniformly through the piping system, would be continuous once they started, and would be instantly recognized.

The cause of the trouble will be found elsewhere, at a check valve with a broken hinge, in a gate valve being used to throttle flow, in a faulty pressure-regulating valve or in one of the faucets. If JGW will make the rounds of his lines, and set up the regulating valves to a point where the tenant will not be tempted to use the faucets to throttle flow, he should erase these complaints.

Marissa, Ill. GEORGE BLUM

Install Vacuum Chamber

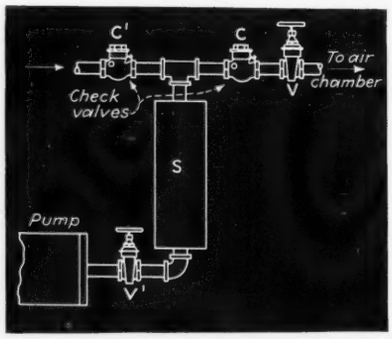
WHEN A DUPLEX PUMP sets up a hammering in the discharge lines, the cause may be defective check valves, or defective suction and discharge valves, which are permitting the charge in the air chamber to drop. Providing these valves are in good order, the only remedy to overcome incessant hammering and hold the charge in the air vessels, would be to install a "vacuum chamber" in the suction pipe. This device will insure a constant level of water for the pump. It will also act as a cushion for water in the suction line when pistons come to the end of their stroke and cause a momentarily sudden stoppage of water flow. See sketch.



Grand Rapids, Mich. J M GORRIE

Keep Chamber Full Another Way

THE SKETCH SHOWS a method of keeping the air chamber of a duplex pump full of air. I have found this to be entirely satisfactory. The cylinder of the pump is tapped for a pipe of suitable size and the fixtures are attached as shown.



By opening the gate valve, when the pump is in operation, and keeping it open until the standpipe is full of water and then closing it gradually until the check valves are working, the pump can be made to keep the chamber full. The standpipe must be big enough so that the pump won't get air bound when the gate valve is open just enough to keep up the air supply.

Wilmington, Calif. T O MCNAMARA

Refill with Bicycle Pump

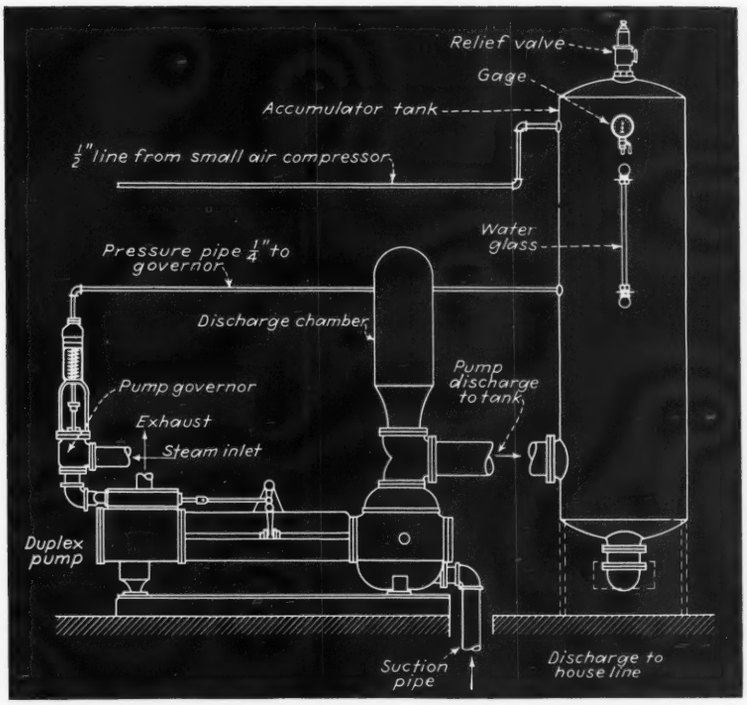
A SMALL LEAK around the plug on top of the air chamber or a porous casting will cause loss of charge over a length of time. Also, a small quantity of air in the chamber will be dissolved by water going through the pump, depending on temperature and pressure.

It is common practice to install a small petcock or snifter valve in the pump suction. A small amount of air will be sucked in when the pump is operating, enough to keep the chamber charged. However, care should be exercised not to get too much air at once, causing loss of suction. The air thus sucked in with the water separates in the air chamber and keeps the latter filled. The loss in efficiency is very slight.

If a positive head exists in the suction line, then a small check valve should be installed to which a bicycle pump can be connected. At regular intervals, a few strokes replenish the air-chamber charge.

If the pump is too small, necessitating high water velocities through the cylinders and valves, it may cause hammering. Another cause is insufficient cushioning of the steam piston, which should also be checked if the continual charging of the air chamber does not produce results.

Fair Lawn, N. J. FCR



Two Solutions

FROM THE INFORMATION given by JGW, I assume that his present hookup is such that the duplex pump discharges directly into the main house pressure line, with no provision for cushioning except for the usual air chamber on the pump. Not knowing the pressure carried, we can give no answer as to the effectiveness of an air chamber in this case.

It is well to remember, however, that when pumps operate above 50 lb, good service requires that air chambers be recharged occasionally by mechanical means or by use of a "snifter". The snifter may be operated by the pump itself. In all probability, the pressure maintained in JGW's house line is such that the proper amount of air cannot be maintained in the chamber, which results in less cushioning effect and hammering in the water lines throughout the building.

In my opinion, especially if the building is a large one, the water system will not function properly with only a conventional air chamber. However, it might be well for JGW to install a "snifter," which can be made on the job. (Ed. Note—See sketch with McNamara answer). It operates as follows: when valves *V* and *V'* are open, water is forced into the snifter cylinder, during the head end discharge stroke. The air in the snifter cylinder is forced into the air chamber through the check valve. During the corresponding suction stroke, the water in the snifter cylinder is drawn back into the pump.

Thus, the snifter again fills with air, through another check valve. Flow through valve *V'* should be throttled on the suction stroke, to prevent all water being drawn from the snifter cylinder. This retains a column of water to act as a piston for driving air through the check valve into the chamber. Valve *V* should be manipulated to establish a regular pulsation within the length of the gage glass on the snifter cylinder. This snifter works only when the pump has a suction lift, and is good up to 200 lb.

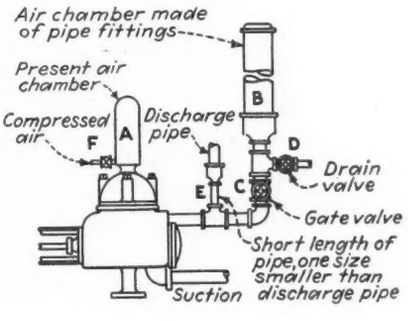
For best results, however, I suggest that JGW consider the installation of an accumulator tank as shown in the sketch. The expense involved will be outweighed by smoothness of operation and by elimination of excessive strains on the piping and pump. The accumulator tank will handle great variations or sudden peak demands often met in large buildings, without undue racing of the pump.

Additional equipment required includes an accumulator tank with necessary fittings such as relief valve, gage, water glass, etc. It will be necessary to provide a small compressor with piping and fittings, to restore the air cushion in the tank, as needed. Compressor can be started and stopped manually. A pump governor should also be installed, if not already in use. This should be of the diaphragm, adjustable-weighted type, to maintain desired pressure in the accumulator.

Cleveland, Ohio A R CIOTTI

Compressed-Air Refill

IF JGW has compressed air available in his plant, at a pressure high enough to overcome the pressure produced by the pump, he can drill and tap a ¼-in. hole in the chamber as shown in the sketch, for a compressed-air connection. Every once in a while he can let in enough compressed air to fill the air chamber.

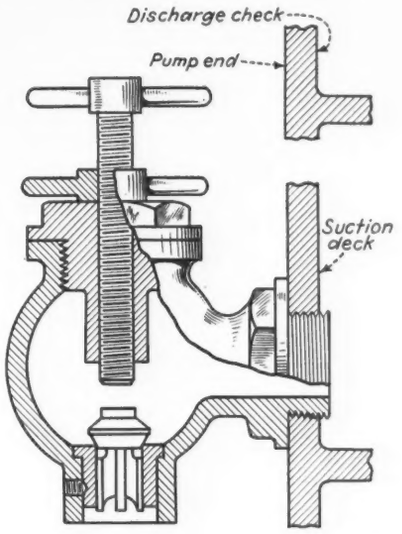


If compressed air is not available, JGW can make an extra air chamber and install it as shown in the sketch. The chamber should have a volume about 5 times the displacement of the pump. The new chamber will increase total volume and can easily be recharged by closing valve *C* and opening valve *D*, which allows water in the chamber to come out so air can take its place.

Toronto, Canada J M FARRUGIA

Gravity Tank Would Help

IT LOOKS as if JGW's pump feeds directly into the house lines instead of to a gravity tank on the roof, as it should. The remedy is obvious, if this is the case. It may be that the pump is too small to handle increased demand since its installation. This would indicate a larger pump, preferably a centrifugal unit.



If investment in these remedies can't be justified, I suggest fitting a pair of snifting valves to each side of the pump between suction and discharge chambers, as shown in the sketch. These valves permit proper amount of air to be drawn in at each suction stroke, keeping the air vessel fully charged at all times. If any cocks or valves are now fitted to the air vessel, remove them, as they cause trouble.

Kearny, N. J. GEORGE MCNALLY

George Edwards Sums Up

THIS QUESTION seems to have hit what the musicians call "a responsive chord", because it certainly drew answers enough. All I can say is that Mr. Farrugia's sketch strikes me as particularly worth looking at again. All you need to make up his air chamber is a vise and pipe wrench, plus odds and ends from the scrap pile and about an hour's worth of time. And as nearly as I can tell, it will work just as well as the more elaborate solutions—GEORGE EDWARDS.

(*Continued on page* 164)

ARGUMENT CORNER

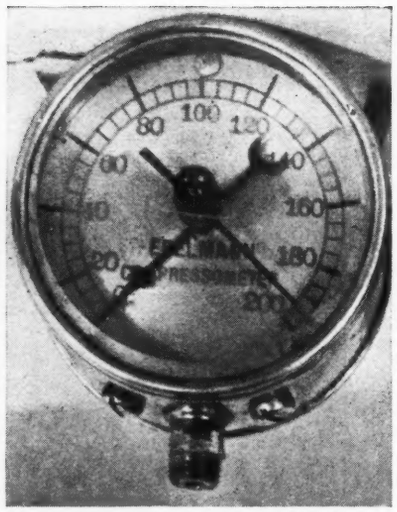
Taking Boilers Out of Service

BACK in February, 1939, we ran an article by S H Coleman called "Ins and Outs of Boiler Outage". This described procedure for taking a boiler out of service, inspecting it, and returning it to service. Mr Armstrong, Power Production Supt, Trinidad Electric Transmission, Railway and Gas Co, Trinidad, Colo., saw part of the article reprinted and wrote us, commenting on one step of Mr Coleman's suggested procedure. The editors, Mr Armstrong, and Mr Coleman would like to hear opinions from other power men on this question. Here's what Mr Armstrong says:

"Under the heading 'Returning Boilers to Service,' it was stated that the superheaters should be drained before starting a fire in the unit. It has been proved by experience that it's much better to leave all superheaters with water in them until pressure was established on the unit, and the water should not be drained out until just before the main valve between the oncoming unit and the main header was opened. In this way, the superheater would be protected from overheating during the starting-up period."

Who Says You Can't

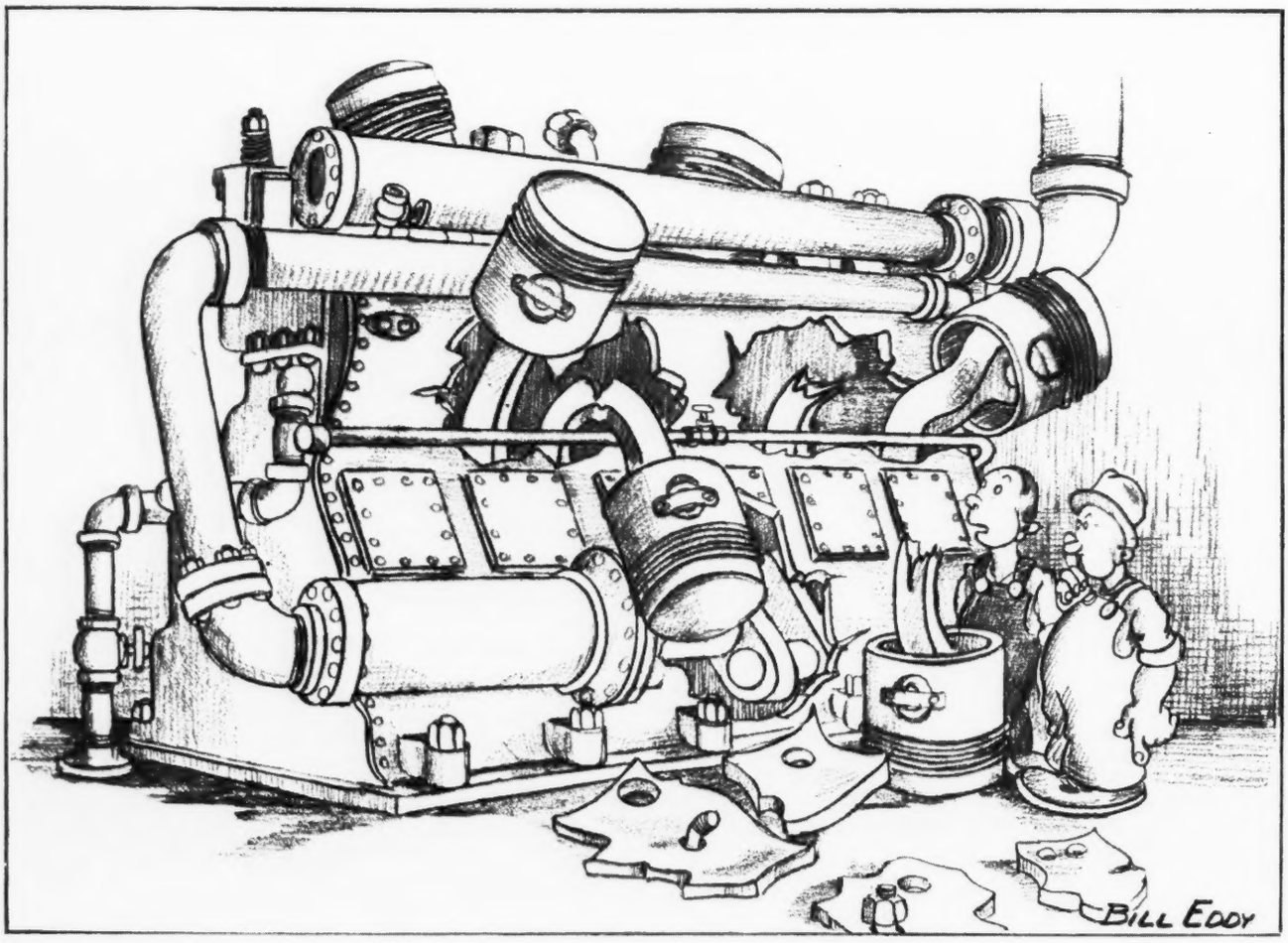
ON PAGE 104 of August, 1939, POWER, S H Coleman cautioned engineers against screwing gages into place by means of the gage casing. I am wondering what Mr Coleman would do



if he had to screw the gage here shown. Note that it has no place to apply a wrench.

I have several pressure gages, three carrying the names of well-known makers. In each of these the threaded nipple, extending through the case, is scarcely longer than the thread for $\frac{1}{8}$-in. pipe. What are you supposed to do in a case like that?

FRED D HOOD *Los Angeles, Calif.*



"Well, what do you know, Old Bessie's sheddin' again"

HOW TO RUN A WATER ANALYSIS

By C A NOLL
Chief Chemist, W H and L D Betz
(Photos by POWER)

Instructions for testing water are presented in four installments:

This month.... How to use the test kit
March..... How to test for hardness
April..... How to test for alkalinity
May..... How to test for chlorides

These three tests can easily be mastered by any engineer or assistant without chemical training. They are the tests customarily made by the plant-operating staff as a matter of daily routine in steam-plant operation.

General Comment

All instructions in this series refer to the kit here shown (Fig. 1). This contains everything necessary to determine hardness, alkalinity and chlorides in raw, treated or boiler water.

The general idea of the tests is to use a measured sample of water, add (except for hardness test) a few drops of certain colored chemical indicators, then add a standard-strength chemical solution until a color change indicates that the reaction is complete. The analysis is figured directly from the amount of chemical required.

The addition of measured volumes of standard-strength chemicals is called a "titration."

Test Kit

The test kit includes the necessary chemicals and glassware. Measure water sample in the 50-cc (50 cubic centimeter) *graduate*. For all tests except hardness, titrate the sample in the white porcelain *casserole*. Left to right, the three small bottles with droppers contain colored *indicators*, as follows:

Potassium chromate, abbreviated "PC" (for chlorides test)

Phenolphthalein, abbreviated "P" (for alkalinity test)

Methyl Orange, abbreviated "MO" (for alkalinity test)

The large bottles contain these chemical solutions of standard strength:

Standard soap solution (for hardness test)

N/50 sulphuric acid (for alkalinity test)

Silver nitrate (strength, 1cc = 1mg Cl) (for chlorides test)

(The expression N/50, meaning "one fiftieth normal," refers to the *strength* of the solution).

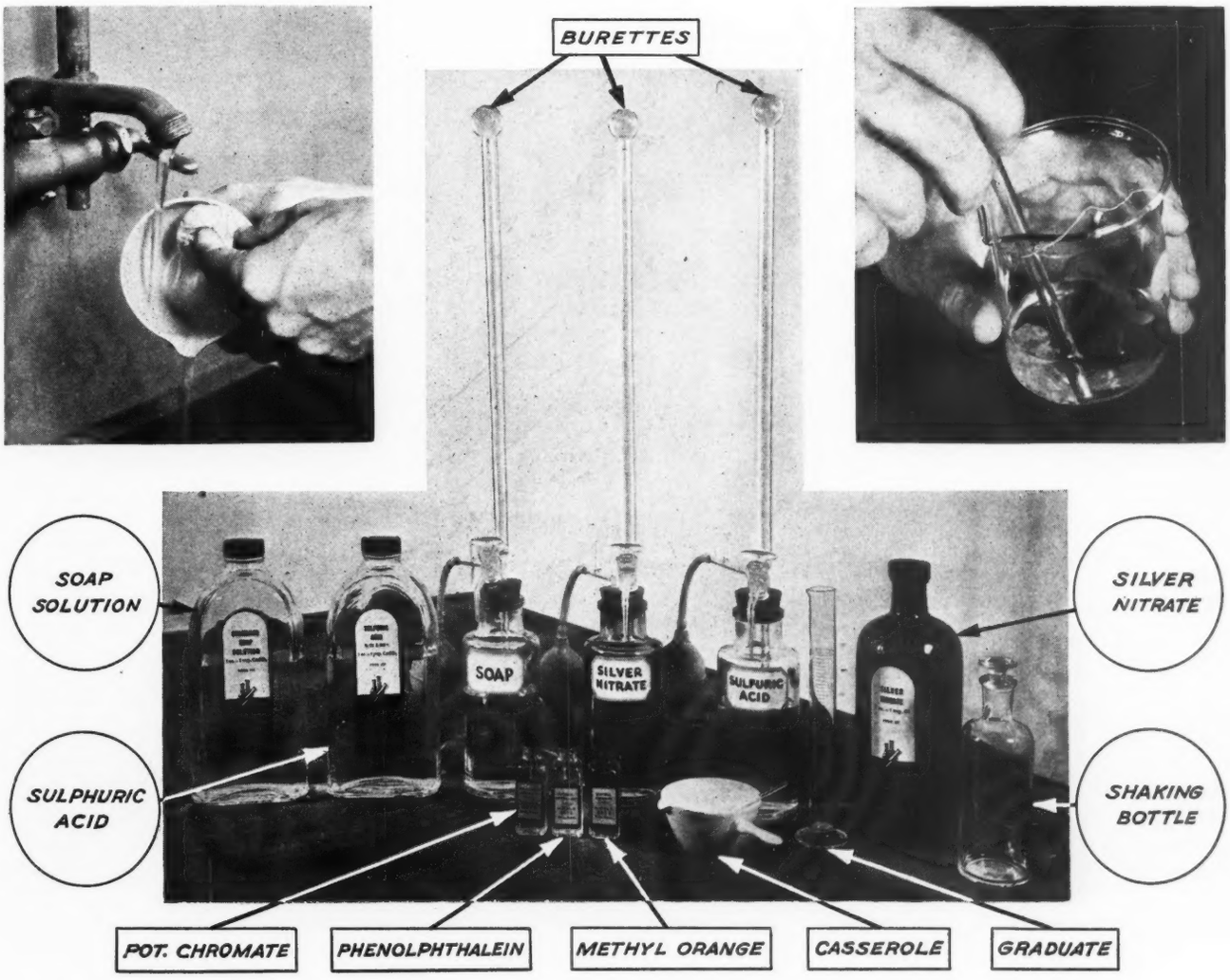
The *shaking bottle*, shown empty, is used to test the durability of the lather in the soap test for hardness. The *burettes* are used to feed measured volumes of the standard chemicals into the sample being tested.

Cleanliness

Go the limit on cleanliness of equipment. After each test, carefully clean

2—Keep utensils clean

1—THE TEST KIT



3—Sodium-chromate crystals, dissolved in conc sulphuric, remove stains

shaking bottle, casserole and sample containers, first with tap water (Fig. 2), then with distilled water. Store kit in a dust-tight cabinet.

If dust and dirt collecting on glassware will not wash off with water, remove stains with a strong chromic-acid solution, made by dissolving a few small lumps of sodium chromate or potassium chromate in concentrated sulphuric acid (Fig. 3). (Handle concentrated acid carefully to avoid burns). After cleaning glassware, rinse first with tap water, then with distilled water.

Water Samples

No test is any better than the sample. Get a *true* sample, free from contamination. If you are sampling boiler water, blow the point of sampling thoroughly before drawing. Don't flash any more into steam than necessary. Let the water run to waste for some time before sampling tap water. Also rinse the vessel first in the tap water.

Reading Liquid Levels

Water or solution in a graduate or burette always has a concave upper surface (meniscus). Never read the high edges. *Read the low center*, and be sure to view it with the eye on a level with the liquid to avoid error.

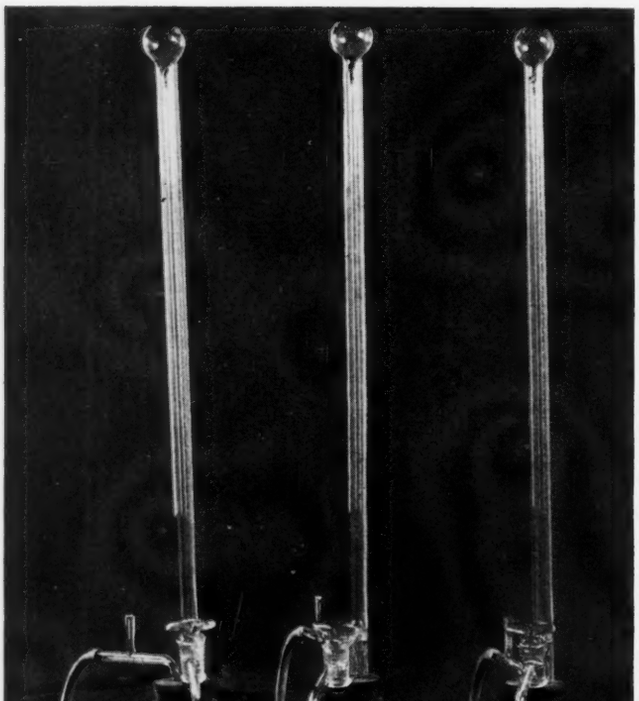
Handling a Burette

A burette is a tall, thin, graduated tube with a dropper at the bottom precisely controlled by a glass stop-cock. The automatic-filling burettes shown are graduated to be read to the nearest tenth of a cubic centimeter (0.1 cc). Each burette should be used and labelled for one chemical only to avoid contamination (See Fig. 4).

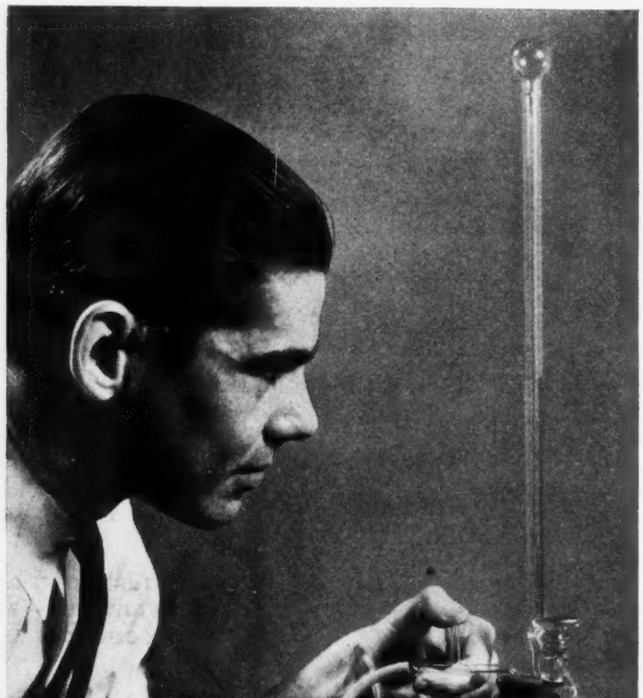
To prepare burette for analysis, remove large stopper (with inserted glassware) and fill bottle half full or more from solution stock bottle. Replace stopper tight.

Then fill burette (Fig. 5) by pumping air into bottle with rubber bulb, closing vent with left thumb. Air pressure in bottle forces liquid up small charging tube inside burette. Charge well up into upper bulb, then remove hands, and liquid will automatically drain down to zero graduation. Then drain a little and recharge (Fig. 6).

6—Drain out a few cc to remove air bubbles around cock. Then recharge

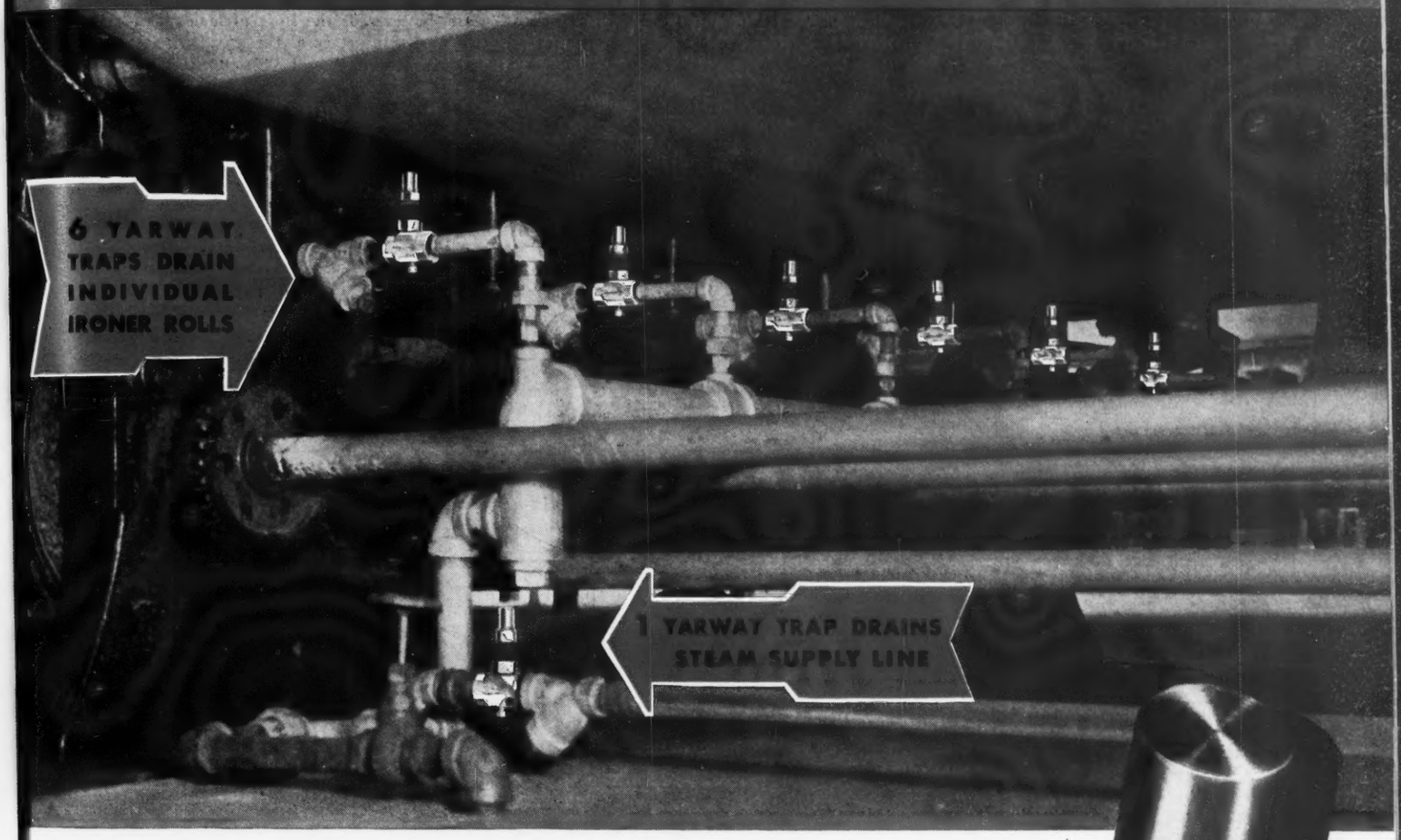


4—Burettes are arranged, left to right, in the order they are to be used in the series of tests



5—To fill automatic burette, plug vent with thumb, pump air into bottle with rubber bulb

Cylinder Twenty Degrees Hotter with YARWAY IMPULSE STEAM TRAPS



Seven of 18 Yarway Traps at Briarcliff Laundry, Atlanta. Notice individual trapping of rolls and steam line.

Owners are "very enthusiastic about Yarway Traps as we have found much better drying is obtained from this machine and other Yarway trapped equipment. On our mangles, for instance, top cylinder temperature has been increased 20 degrees."

Not only for quicker heating and greater sustained heating efficiency; but for many other distinct advantages—Yarway Traps are replacing less efficient, less dependable devices in many plants.

Have you investigated this trap about which user says,—"saves fuel,"—"saves space,"—"easier and cheaper to install,"—"we like its flexibility on different pressures,"—"saves maintenance trouble and expense,"—"cheaper to replace with Yarways than to repair old-type traps," etc., etc.

More than 60,000 Yarway Impulse Traps are already in service and orders this year are at an all-time high—as satisfied users call for more and more.

End your trap troubles. Ask for Bulletin T-1734 or see your local mill supply distributor.

YARNALL-WARING COMPANY, 100 Mermaid Ave., Philadelphia

YARWAY IMPULSE STEAM TRAP

Engineers' Bookshelf

Internal-Combustion Engines

INTERNAL-COMBUSTION ENGINES (5th Edition, 1939). *By Lester C Lichty, Yale University. Published by McGraw-Hill Book Co, 330 W 42nd St, New York, N. Y. 603 pages, 6x9 in., 397 illustrations, appendix with tables and charts, cloth binding. Price $4.50.*

In this 5th edition, Prof Lichty assumes full authorship of the text formerly known as "Streeter and Lichty". The same general scheme is followed as in previous editions, but analysis of combustion and thermodynamic processes has been simplified by the direct use of the general energy equation with the chemical energy concept.

New knowledge of fuels and their characteristics necessitated rewriting the chapters dealing with fuels, detonation, and fuel injection. A short chapter on spark ignition has been added. Other subjects receiving more extended treatment due to technical and research advances are: combustion-chamber design, heat losses, air cooling of engines, lubrication, and materials of engine construction.

Diesels

AMERICAN DIESEL ENGINES (2nd Edition, 1939). *By Lacey H Morrison. Published by McGraw-Hill Book Co, 330 W 42nd St, New York, N. Y. 489 pages, 6x9 in., 306 illustrations, cloth binding. Price $5.00.*

This new edition brings up-to-date Mr Morrison's well-known treatment of American diesel practice. Following the basic plan of the first edition, the author gives brief descriptions of current engine designs before taking up detailed discussion of engine elements. Chapters on lubrication, cooling systems, and diesel installation round out the work. In line with current trends, this edition devotes more attention to high-speed engines, to solid-injection systems, and to fuels and their combustion.

History of Science

A HISTORY OF SCIENCE, TECHNOLOGY, AND PHILOSOPHY IN THE EIGHTEENTH CENTURY (1939). *By A Wolf, University of London. Published by The Macmillan Co, New York, N. Y. 814 pages, 6x9½ in., 345 illustrations, cloth binding.*

In this second volume of his projected History of Science Library, Professor Wolf carries on his great historical feat of relating progress in the theoretical sciences, in practical technology, and in philosophy and the social sciences. With the seething 18th Century for his field, the author surveys the rapid developments in mathematics, mechanics, astronomy, astronomical and marine instruments, light, sound, heat, electricity and magnetism, meteorology, chemistry, geology, geography, botany, zoology, medicine, agriculture, textiles, building, transport, powerplant and machinery, mining and metallurgy, industrial chemistry, telegraphy, psychology, economics, and philosophy.

Apart from genuine respect for Professor Wolf's range of knowledge, the reader's outstanding reaction is enthusiasm for the kind of history this book represents. The usual history, with its emphasis on political developments, wars, and other less praiseworthy activities of mankind, often leaves the reader with a negative reaction. Here, however, is the story of man's creative works, the story of the great thinkers and builders who have carried the torch of civilization. Engineers with an interest in our scientific heritage will enjoy this encyclopedic book.

Insulation

SYMPOSIUM ON THERMAL INSULATING MATERIALS (1939). *Published by the American Society for Testing Materials, Philadelphia, Pa. 123 pages, 6x9 in., illustrated. Price, paper covers, $1.25; cloth, $1.50.*

The four technical papers comprising this symposium were presented at the Columbus Regional Meeting of the ASTM, held March 8, 1939. Fundamental principles of heat flow and other basic considerations are discussed in the first paper: "Factors Influencing the Thermal Conductivity of Materials", by J B Austin, Research Laboratory, U S Steel Corp. H H Rinehart, Johns-Manville Research Laboratories, in "A Discussion of Test Methods for Determining the Physical Properties of Thermal Insulation", covers problems being studied in the effort to develop standards for gaging acceptability of materials.

Looking at the problem from another viewpoint, E T Cope and W F Kinney, Detroit Edison Co, tell of difficulties in purchasing and using insulating materials, in their paper "One Consumer's Problems in Selecting Thermal Insulation". The concluding paper, "Effect of Solar Radiation on the Heat Transmission Through Walls" by F C Houghton, Carl Gutberlet and A A Rosenberg of the ASHVE Research Laboratory, presents fundamental principles and actual data on cyclic heat flow through walls influenced by solar radiation.

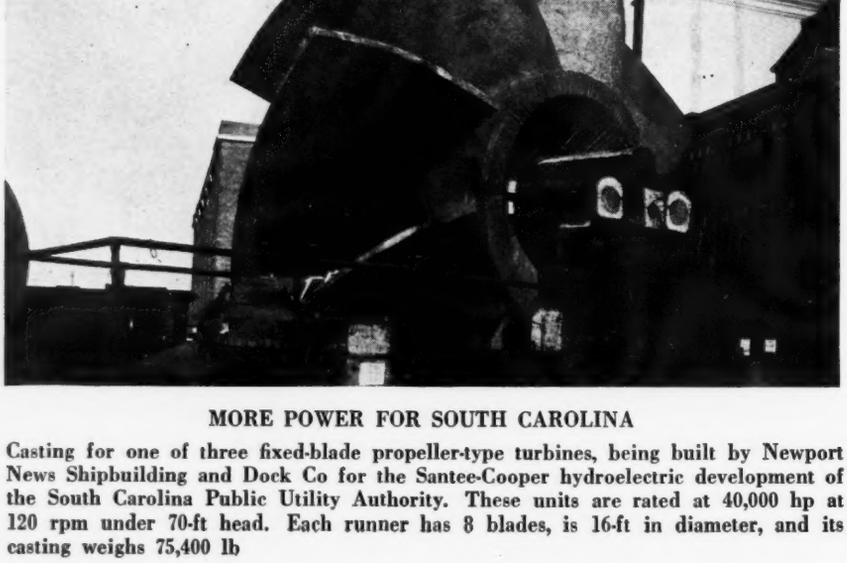
Gas Engines

GAS-ENGINE HANDBOOK (1939). *Prepared and published by the Gas Engine Power Committee, Industrial Gas Section, American Gas Association, 420 Lexington Ave, New York, N. Y. 58 pages, 8½x11 in., illustrated with charts and photographs, paper covers. Price $1.00.*

Based on years of experience with gas-engine power, this handbook gives, in nontechnical language, the essential information needed for intelligent engine application. It is aimed primarily at men engaged in the sale and promotion of gas engines and does not cover operation or maintenance.

However, the discussions of gas-engine history, the operating cycle, auxiliaries, waste-heat recovery, automatic controls, and electrical equipment should prove valuable to all interested in gas engines. Of particular worth are the extensive

(Continued on page 132)



MORE POWER FOR SOUTH CAROLINA

Casting for one of three fixed-blade propeller-type turbines, being built by Newport News Shipbuilding and Dock Co for the Santee-Cooper hydroelectric development of the South Carolina Public Utility Authority. These units are rated at 40,000 hp at 120 rpm under 70-ft head. Each runner has 8 blades, is 16-ft in diameter, and its casting weighs 75,400 lb

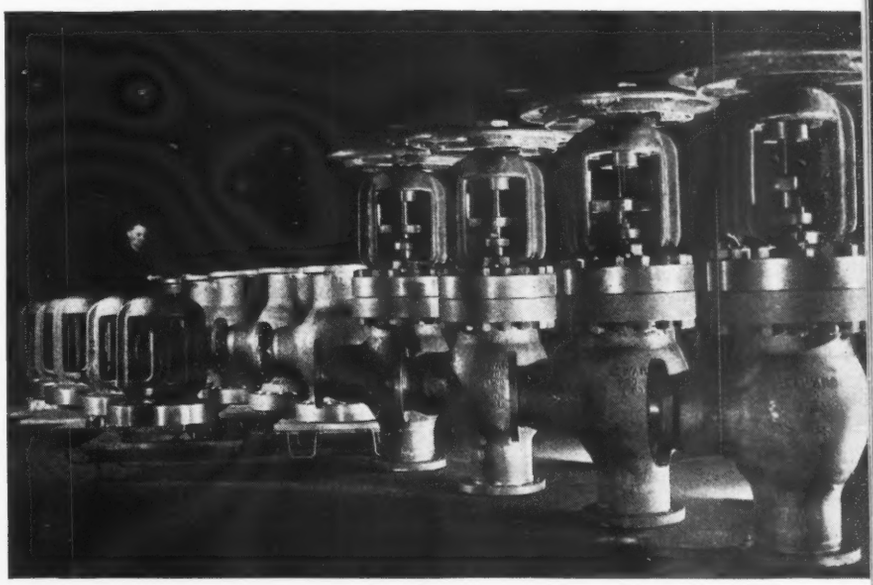
Photo News valve values

TITLE REG. U. S. PAT. OFFICE AS TRADE MARK

THE EDWARD VALVE & MFG. CO., INC. • EAST CHICAGO, INDIANA

MORE STEAM OUTPUT — MORE EDWARD NON-RETURN VALVES!

With nearly three million KW of new power generating capacity slated for installation in 1940-1, Edward non-return valves will control a lot of new steam output — judging from orders already booked. More than ever, the latest Edward steel valves for 150 lb up — way up — represent high dollar value as well as high reputation. Among Edward non-return valve values to check — most of them exclusive — are (1) three-point, self-scouring, non-jamming guide ribs; (2) hour glass free-flow disk-piston; (3) EValloy shock-preventing piston rings; (4) EValthrust combination end and radial thrust yoke bushings; (5) Edward Impactor hand-wheel for ease of manual operation; (6) clever internal contouring to minimize back currents and head loss — not to enumerate last word technique in proved materials, Stellited contact surfaces, welding ends or what have you!



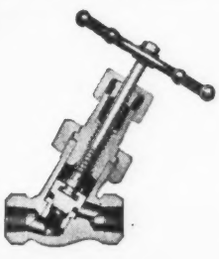
Above—Here are parts of nine (four fully assembled) 10 inch 1500 lb non-return valves with test flanges for the three new petroleum refinery plants powered by Pacific Gas and Electric Co. at Avon, Martinez and Oleum, California. Left — Stelliting forged steel disks for valves shown above in revolving, gas fired furnace, and, right — one of the body castings after shaking out of the foundry sand and before removing headers . . . pouring weight about 5000 lb per body.

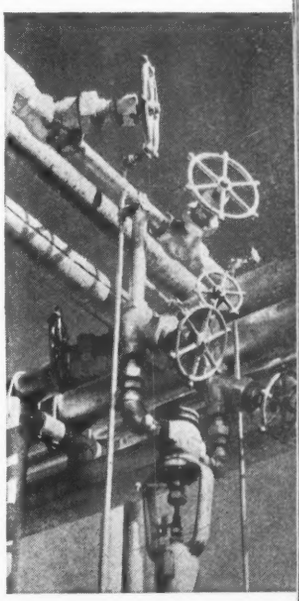
EDWARD MARINE VALVES ON FIRST STEAM "C2" SHIP

Edward steel valves went to sea on the SS Challenge. This was the first of six turbine drive ships of the Maritime Commission's "C2" class to leave the ways of the Federal Shipbuilding and Dry Dock Company. Equipped with Foster Wheeler boilers and General Electric turbines, the vessel was credited on its trial runs with a world's record in fuel economy for marine propulsion machinery. Boiler operating pressure is 450 lb per sq. in. and final steam temperature 750 F. Edward builds a wide range of cast and forged steel valves for marine steam generating systems.

FIND VARIED USES FOR EDWARD F. S. VALVES

F. S. of course means forged steel. As industrial chemists open startlingly useful fields of activity and petroleum technologists break new trails, no end of jobs for Edward forged steel valves appear. For high pressures and high temperatures, for corrosion resistance, stamina, long life and low overall cost, small valves of forged steel are usually best. Shown at left is Edward Fig. 2698 (inside screw), sister series to Fig. 2688 (OS&Y). The 1940 vintage, retaining the simplicity of design, tested materials, good workmanship, which have long made them a smart buy, tops all Edward valves that have gone before. Right — Easy operating Fig. 2698s, on refinery process lines.





EDWARD Valves

STOP • CHECK • BLOW-OFF • NON-RETURN
FEED-LINE • RELIEF • BLEEDER LINE • ETC.

East Chicago, Indiana

Power Lines

POWER'S History

POWER was founded in 1884 by E P Harris and H M Swetland. With it was incorporated *Steam*, which had been started by N Hawkins in Chicago two years earlier.

In 1903 POWER purchased and absorbed *Science and Industry*, which was a consolidation of a number of periodicals, namely, *Home Study Magazine, Home Study for Machinists, Mechanic's Magazine, Home Study for Building Trades, Building Trades Magazine, Home Study for Electrical Workers* and *Steam Electric Magazine.*

In 1908 POWER absorbed *The Engineer's Review*, of Cleveland, and *The Engineer*, of Chicago, the latter being a consolidation of *The Safety Valve, Lord's Power and Machinery Magazine, The Stationary Engineer, Steam Engineering and The Mechanical Engineer.* When *The Engineer* was purchased, the name of the combined magazine was *Power and the Engineer.* The title was condensed to POWER in 1911. All rights to the above titles reserved.

Westinghouse Establishes $25,000 Trust Fund

American Institute of Electrical Engineers announce the setting up of a $25,000 trust fund to provide graduate fellowships in electrical engineering. The fund was established by the Westinghouse Electric & Mfg Co, East Pittsburgh, Pa. The educational trust will be known as the Charles LeGeyt Fortescue Fellowship, a memorial to the late Dr Fortescue, "in honor of his outstanding achievements and valuable contributions to the electrical industry". Beginning in 1940 the fellowship commission of the A I E E will select "the most promising candidates" to receive the Fortescue awards, which provide a minimum allowance of $500 each. The 1940 awards will be made before April 1.

Duquesne Light Co Starts New Construction for 1940

Beginning a $16,000,000 construction program, the Duquesne Light Co, Pittsburgh, announces the placing of an order for an 80,000-hp generating unit. This steam turbine-generator will be installed at the James H Reed Power Station on Brunot Island, and will increase the total capacity of the system to 752,000 hp. Cost of the turbine and auxiliary equipment is expected to reach $5,000,000.

The turbine-generator will be substantially the same as the two units installed previously and that are now operating at the station. The first was completed in 1930 and the second on December 14, 1938.

Regular construction budget for the year of 1940 includes extensions to substations, high-voltage line extensions, additional distribution facilities, and increased transformer capacity throughout the system. In order to supply coal for the additional generating capacity, new mining machinery will be installed in the coal mines at Harwick and Warwick.

Public Service Co Orders 18 Auxiliary Motors

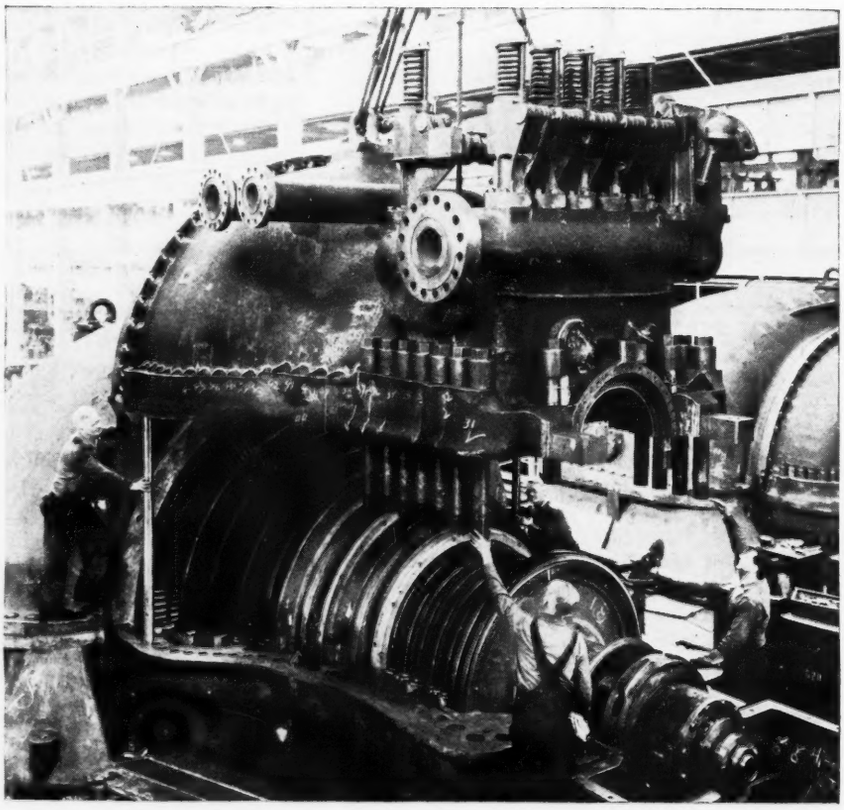
One of the largest single orders for power-station auxiliary equipment awarded during the past two years was given the Westinghouse Electric & Mfg Co recently for 18 auxiliary motors with a combined output of 14,800 hp, costing approximately $121,000.

The order was placed by the Public Service Electric & Gas Co, Newark, N.J., for installation in the new extensions of the Marion and Burlington Power Stations, Newark, late in 1940. The motors are designed for the operation of boiler-feed pumps, condensate pumps, circulating pumps and other power-station equipment, and range in size from 200 to 1350 hp.

OBITUARIES

FRANCIS J SHIRING, 62, manager of factory service at the East Pittsburgh Works, Westinghouse Electric & Mfg. Co, died at his home on December 22, 1939. Mr. Shiring had been a Westinghouse employee for 45 years. He was born in Pittsburgh in 1877, and after attending elementary schools in Pennsylvania, he entered the Westinghouse company in 1894. Following his work in numerous positions in the company in the next 25 years, he took charge of the Automotive Equipment Div. Two years later he was made superintendent of the large industrial motor aisle, and after five years in this position was appointed superintendent of production, from 1923 to 1926. Transferred as superintendent of motor and control division, he was promoted to assistant works manager in 1928, and on January 1, 1936, was made manager of factory service.

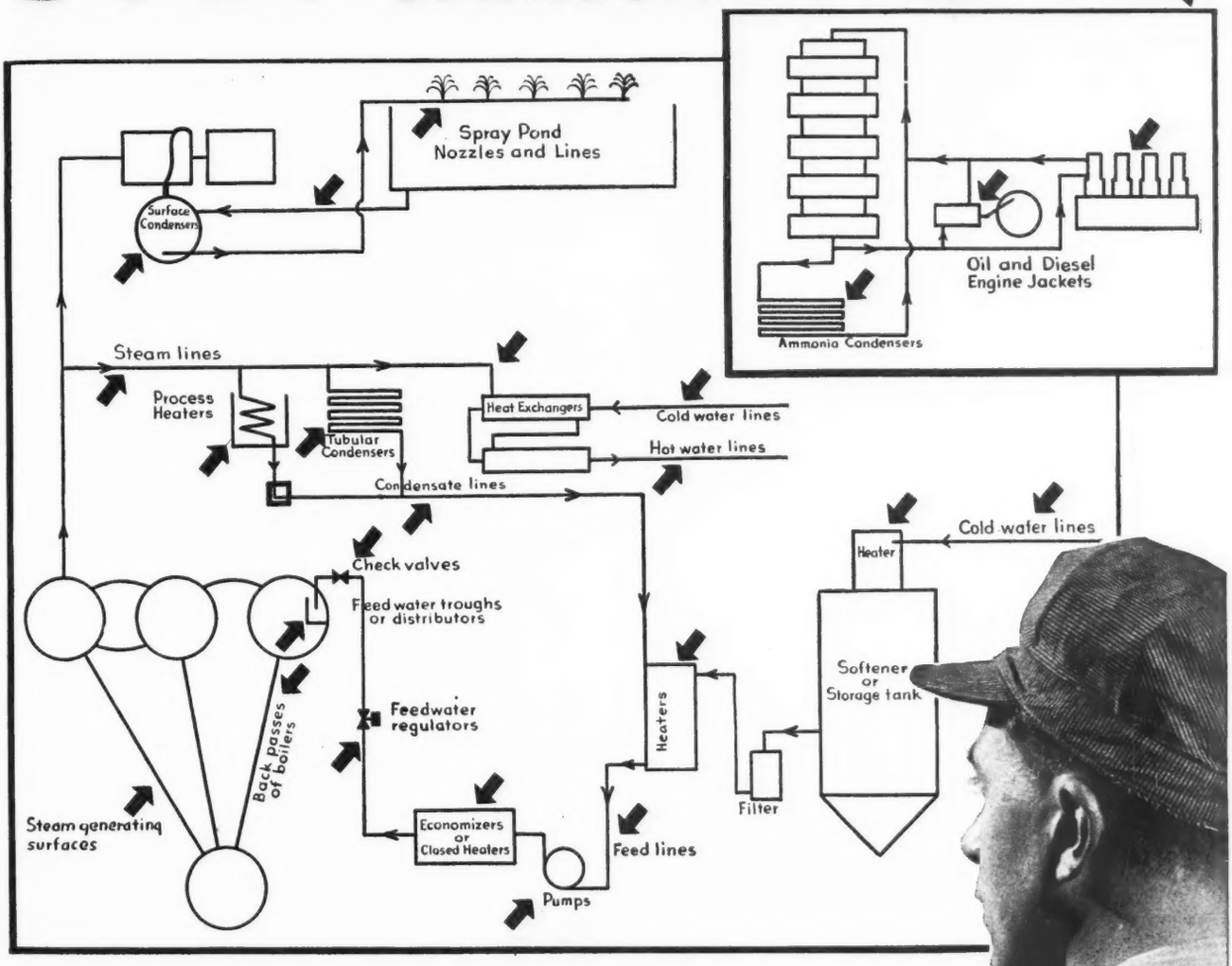
EDWIN W ALLEN, 60, vice president of General Electric Co since 1926, died at noon January 1 at Johns Hopkins Hospital, Baltimore, where he had been under treatment following an operation. Mr Allen was a native of Virginia, was graduated from Virginia Polytechnic Institute in 1900, and entered the employ of General Electric Co as a student engineer the following year. He started at Schenectady, was transferred to Chicago, where he remained, except for war service, until 1924, when he was named manager of the Engineering Dept and transferred back to Schenectady. During the war he served



OSWEGO TURBINE

Rated at 80,000 kw, this turbine is the largest built since 1931, and is the first of two units for Oswego Station of Central New York Power Corp. Hydrogen-cooled turbine is also first large 1200-lb condensing unit built in a single casing and will operate at 1800 rpm, 900 F. Photo shows unit on test at General Electric Schenectady Works

STOP SCALE AND CORROSION HERE!

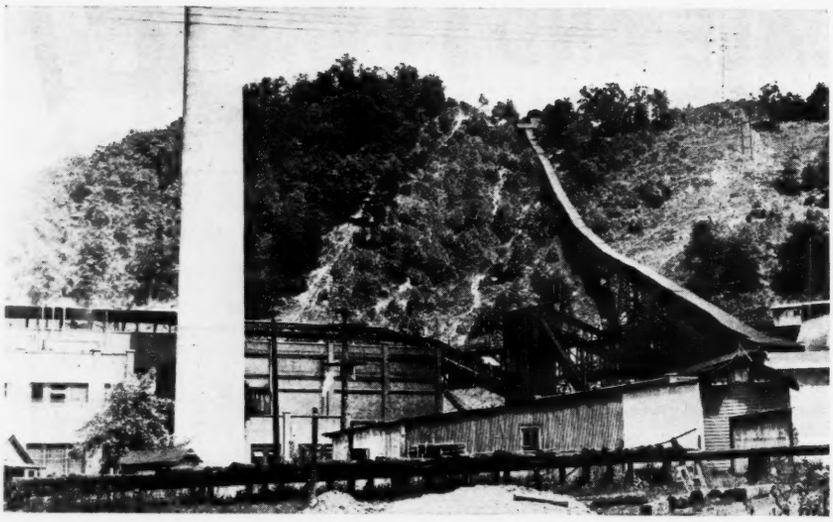


YOU know from experience that scale or corrosion, or both, can cause trouble in many places besides your boiler tubes and drums. But what you may not know is that Nalco offers service to prevent such trouble. Many Nalco customers are now taking advantage of this complete service. The advantages are obvious: (1) One responsibility for your entire plant. (2) Low combined cost. (3) Regular, systematic attention given to all of your problems. We will be glad to give you details on this *complete* treating service.

Write. **NATIONAL ALUMINATE CORPORATION, 6222 W. 66th Place, Chicago, Illinois.**

ANY WATER **NALCO SYSTEM** ANY PRESSURE

Inquiries other than domestic *except those from U.S. Possessions, Canada and Mexico,* should be addressed to ALFLOC LTD., Bush House, Aldwych, London, W. C. 2, Eng. Canadian inquiries should be sent to ALUMINATE CHEMICALS LTD., 372 Bay St., Toronto, Ont.



NO FUEL WORRIES

Unusual plant of Kentucky and West Virginia Power Co at Hazard, Ky., has fuel problems taken care of by individual mine adjacent. As shown, coal is conveyed directly from mine to plant. Contract with mine officials assures steady fuel supply, regardless of labor disputes, but just to be on the safe side, provisions have been made for shipping and conveying coal into plant by rail. Photo by Dana Gibson

with the advance party of the 86th Division in September, 1918, and following the armistice was ordered to duty with the War Damage Board of the Peace Commission, which met in Brussels. He resumed his duties with General Electric in 1919. Mr. Allen was a fellow of the American Institute of Electric Engineers, and a member of the Western Society of Engineers.

PERSONALS

CHARLES G WILLIAMS, formerly vice-president in charge of purchasing and manufacturing operations for the American Chain and Cable Co, has been appointed general manager of John A Roebling's Sons Co, Trenton, N.J. Mr Williams was born in Hartford, Conn., on August 25, 1885. He was given a degree in Mechanical Engineering from the Sheffield Scientific School, Yale University, '08. After leaving college he was employed for a time by the Engineering Dept of Terry Steam Turbine Co, then joining the American Chain and Cable Co as purchasing agent. In 1930 he was made a director of the company, and in 1936 was appointed vice-president in charge of all manufacturing operations. He will assume his new duties on March 1.

L A MULLEN has been appointed assistant manager of sales for the Pittsburgh Steel Co, an appointment which took effect January 1. He has been associated with the company since January, 1938, first as assistant district sales manager at New York, and later as district sales manager at Chicago. Before joining his present employer, Mr Mullen was with the Republic Steel Co, in various capacities.

PATRICK J O'SULLIVAN, formerly in charge of plant operation at Camp Devens, Mass., and lately in the custodian department of the Boston Schoolhouse Commission, has been appointed chief engineer of the new court house building in Pemberton Square, Boston, succeeding William J Armstrong, recently resigned.

COMMISSIONER LELAND OLDS, of New York, has been elected chairman of the Federal Power Commission, effective January 1. Before his appointment by President Roosevelt to the Federal Power Commission last June, Mr Olds was for a number of years executive secretary of the Power Authority of the State of New York.

ROBERT A JONES has been appointed district engineer in the New York district of the General Electric Co. The appointment went into effect January 1. Mr Jones was graduated from the University of Minnesota in 1916 and entered the test course at General Electric the same year. In 1918 he was transferred to the industrial engineering department in Schenectady, and engineer in the Syracuse office in 1923. He was sent to the Buffalo office in 1936, and on December 1, 1938 he was appointed assistant engineer of the New York district. W S Hill was named assistant district engineer.

DR WILLIAM A MUDGE has joined the Technical Service Div of the International Nickel Co, with headquarters at the New York office. For the past 17 years, Dr Mudge has been superintendent of research, superintendent of the refinery and works metallurgist at the company's Huntington, W. Va., rolling mill. Before going to the Huntington Plant, Dr Mudge spent two years at the Bayonne, N.J., refinery. He joined the International Nickel Co in 1920.

HAROLD W STODDART has been made manager of the Turbine Well Pump Div of the Worthington Pump & Machinery Co. Mr Stoddart is a graduate of the Iowa State College and joined the Worthington organization in 1919, at the time of his graduation.

WILLIAM C WINKLER has joined the staff of the Young Radiator Co as assistant sales manager of the Catalog Products Div. Mr Winkler is a graduate engineer of California Institute of Technology. He has served with the Westinghouse Electric & Mfg Co, and been affiliated with the John A Connelly Co. He will maintain his office in Racine, Wis.

FRANKLIN D FOWLER, recently president and operating head of Foote Bros Gear and Machine Corp, Chicago, has been appointed assistant to the president and executive head of operations of American Machine & Metals, Inc, East Moline, Ill. He has served as foreman, master mechanic, general superintendent, salesman and sales manager. His industrial experience includes work in the machinery sheet-metal manufacturing and structural fields. Mr Fowler became president of the Construction Machinery Co, and since 1932 has been the head of Foote Bros.

At a recent meeting of the Board of Directors, FRANK T KALAS was elected 3rd vice president of the Electric Storage Battery Co. Mr Kalas has held the positions of salesman, Washington branch manager, district manager, assistant general sales manager and general sales manager. As vice-president he will direct the sales activities of the company.

C N JOHNS, vice-president of the American Chain & Cable Co, Inc, has been placed in charge of operations, to take over the duties of C G Williams, whose resignation is announced. Mr Johns is a graduate of the University of Missouri, and has had many years of experience in the steel industry. He has served with company for 27 years, his service being interrupted only during the war, when he saw service.

GEORGE C MOON, a vice-president of the American Chain & Cable Co, Inc, has been appointed general manager of sales of the company. He has been associated with the present company for about 14

Meetings

American Society of Mechanical Engineers—*Spring meeting, May 1–3, 1940, Worcester, Mass. C E Davies, secretary, 29 W 39th St, New York, N. Y.*

American Institute of Mining and Metallurgical Engineers—*Annual Meeting, February 12–16, 1940, New York, N. Y. A B Parsons, secretary, 29 W 39th St, New York, N. Y.*

National District Heating Assn—*Annual Meeting, May 14–17, 1940, French Lick Springs Hotel, French Lick, Indiana. John F Collins, Jr, secretary-treasurer, 1231 Grant Bldg, Pittsburgh, Pa.*

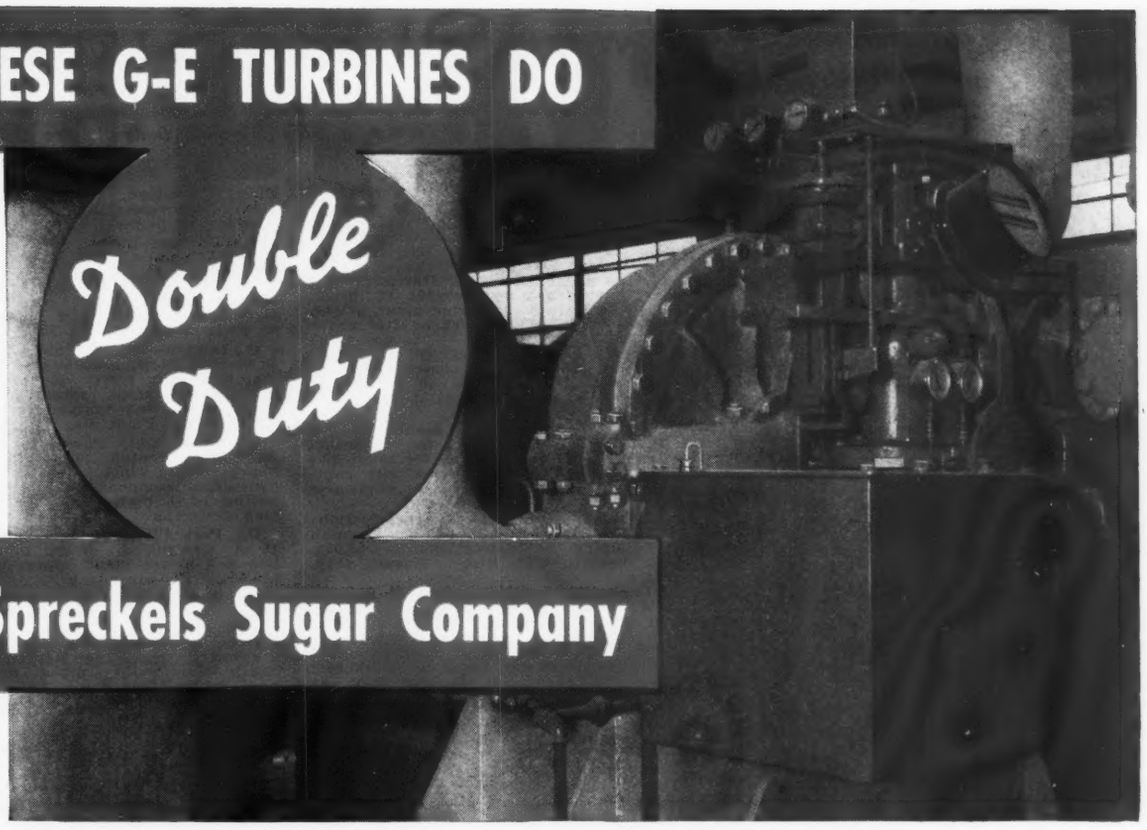
Heating, Piping and Air Conditioning Contractors National Association—*Annual Convention, May 27–30, Hotel Pennsylvania, New York, N. Y. Joseph C Fitts, secretary, 1250 Sixth Ave, New York, N. Y.*

Midwest Power Conference—*Palmer House Hotel, Chicago, Ill., April 9–10, 1940. Charles A Nash, secretary of 1940 conference, 4715 N Spaulding Ave, Chicago, Ill.*

THESE G-E TURBINES DO

Double Duty

for Spreckels Sugar Company

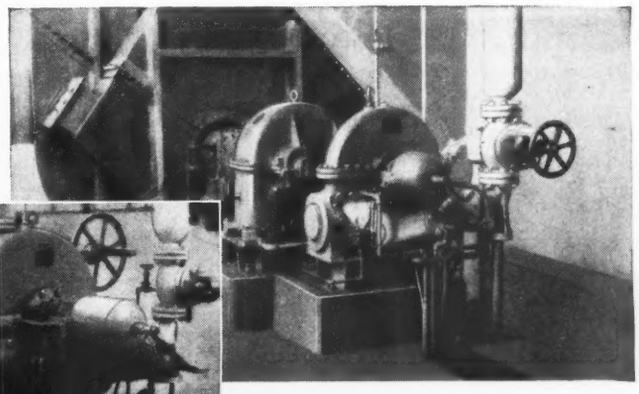


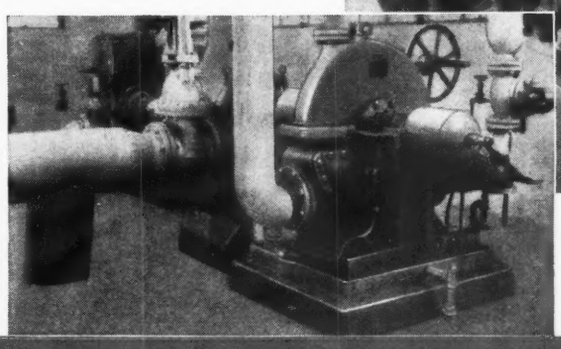
515-hp G-E turbine used to drive centrifugal refrigeration compressor

IN the modern beet sugar factory of the Spreckels Sugar Company in Woodland, California, these G-E mechanical-drive turbines are providing continuous drive for compressors, boiler draft fans, and centrifugal battery supply pumps—and the exhaust steam is used for process throughout the plant. This is an example of the efficient, ***double-duty*** service that G-E turbines give.

The units are in service 24 hours a day, seven days a week, require little attention, have good speed regulation, and are easy to operate, according to a report made by the general superintendent of the plant. Since all exhaust steam is used in the multiple evaporators or at other points in the plant where heating steam is required, the full economy of inexpensive by-product power for auxiliary drive is obtained.

When you are considering a turbine installation, it will pay you to call the turbine specialist at the nearest General Electric office. Use his broad experience to effect operating savings in your plant. He will be glad to help. General Electric, Schenectady, N. Y.





ABOVE. 182-hp gear-turbine driving boiler draft fan

LEFT. This 50-hp turbine drives a centrifugal battery supply pump

GENERAL ELECTRIC

720-320

years. During that time he served as a vice-president and had supervision of sales of the Wire-Rope Division and in the sales promotion of preformed wire rope. In his new capacity he will continue in active supervision of wire rope sales; his headquarters will remain at 230 Park Ave, Grand Central Bldg, New York, N.Y.

R L HARTER has been appointed chief engineer of the Trabon Engrg Corp, Cleveland, Ohio. Mr Harter, a graduate of the U.S. Naval Academy, has recently resigned from his position as industrial engineer of the Alemite Div, Stewart-Warner Corp. Except during the World War, when he served in the U.S. Navy, Mr Harter has devoted all of his time to the industrial field, and for the past seven years has specialized in the development of lubrication and lubricating equipment.

EDWARD I PFAFF has been appointed sales manager of the Trabon Engrg Corp, Cleveland. Mr Pfaff has been associated with the industrial lubrication field for the past 12 years as a special industrial representative of the Alemite Div, Stewart-Warner Corp.

On March 1, 1940, J K WOOD will return to active duty as chief engineer of the General Spring Corp, New York, N.Y., after having been temporarily connected with the Grinnell Co, Inc, Providence, R.I. and the Babcock & Wilcox Co, Ltd, London, England, for the past 3 years.

ROGER C JONES, P O Box 1421, Hartford, Conn., has been appointed sales representative of the Terry Steam Turbine Co. His territory will include the whole state of Connecticut.

W B MOORE, associated with the Timken Roller Bearing Co, in various sales activities for the past 20 years, has been appointed director of sales of the Steel and Tubes Div. Mr Moore joined the company as an engineer early in 1919 after his graduation from the University of Michigan. After several years of engineering and sales training in the Canton office, he was placed in charge of the company's Pacific Coast District. Since 1933 he has been manager of industrial sales.

BUSINESS ITEMS

TURBINE PUMP DIV, ROOTS-CONNERSVILLE BLOWER CORP, announces appointment of following territorial representatives: J A Dodd, 101 Marietta Bldg, Atlanta, Ga., entire state of Georgia; Smith & Berry, 1316 First Ave, N, Birmingham, Ala., entire state of Alabama, with exception of Mobile; L W Oakley, 408 W Clinch Ave, Knoxville, Tenn., state of Tennessee, with exception of western counties comprising Memphis area, and several counties in Western N Carolina; Leo L Roussell, 2733 Dumaine St, New Orleans, La., lower half of Louisiana and Mississippi; B G Peterson, 6235 Florence Blvd,

(Continued on page 148)

NEW PLANT CONSTRUCTION

McGraw-Hill Business News Department Is Prepared to Furnish a More Complete Daily Service

Calif., San Francisco—Acme Breweries Co., 762 Fulton St., plans constructing 4 or 5 story, Class "A" bottling plant, malt house and grain storage building. $350,000 or more.

Conn., Bridgeport—Southern New England Ice Co., Hallam St., plans by Keith Sellers Heine, 101 Mohawk Dr., West Hartford, constructing 1 and 2 story, 100x292 ft. brick, steel, concrete ice manufacturing plant, offices, garage facilities. $400,000. Three sites under consideration.

Fla., Fort Lauderdale—Shell Oil Co., Shell Bldg., St. Louis, Mo., plans constructing distribution plant, S. Miami Ave., in Port Everglades, suburb of Fort Lauderdale. $1,000,000. Private plans.

Idaho, Idaho Falls — City plans $150,000 bond election to raise funds for expansion and purchasing new equipment for municipal hydro-electric plant. C. R. Black, city engr.

Ia., Algoma—City plans expansion electric power plant. Adah Carlson, city clk.

Kan., Winfield—City making specifications furnishing, installing feed water heater, with auxiliary piping at power plant. $5,000. Black & Veatch, 4706 Bway., Kansas City, Mo., engrs.

Ky., Louisville—Louisville Gas & Electric Co., L. W. Pickel, supt. special constr., 311 W. Chestnut St., appropriated $2,015,615 for construction work, incl. new electrical substation, improving, maintaining electrical distribution, 2 or 3 unit type substations to be purchased, improving switching station equipment at Waterside, Canal and Hydro plants, etc.

La., Baton Rouge—Standard Oil Co., North Baton Rouge, plans expansion program, construction alkylation plant unit. $2,000,000. Engineer, c/o owner.

Mich., Detroit—Bundy Tubing Co., 10951 Hearn St., plans constructing 1 story, brick, steel, concrete factory, plain foundation, vicinity of Detroit. $150,000. Site acquired.

Minn., Minneapolis—Bunge Elevator Corp., 369 New Chamber of Commerce Bldg., rein.-con. elevator, 500,000 bu. capacity, 917 13 Ave. S.E. $300,000. Private plans.

Miss., Clarksdale — City, c/o T. M. Dye, mayor, plans reconstructing electric power plant, new machinery and power lines, new buildings. $216,000. E. P. Fryant, Clarksdale, engr.

Mo., Koch—Bids Jan. 26, by City of St. Louis, c/o B. L. Brown, pres. Bd. Pub. Serv., 304 City Hall, St. Louis, constructing alterations and additions to rein.-con., brick power plant building at Robert Koch Hospital. $85,000. PWA. A. Osburg, archt., and W. C. Becker, engr., both 301 City Hall, St. Louis.

Neb., Hastings—City Council voted to advertise for bids for 3,500 kw. generator for power plant.

Neb., Nebraska City—Nebraska City Dock Bd. plans constructing 18-cell rein.-con. storage elevator. $300,000. Horner & Wyatt, Bd. Trade Bldg., Kansas City, Mo., engrs.

Neb., Omaha—Roberts Dairy Co., 29 and Cuming Sts., bids in about 6 weeks, remodeling entire plant. $125,000. J. T. Allan, Brandeis Theatre Bldg., Omaha, engr.

Neb., Spencer—Nebraska Hydro Electric Co., Spencer, plans rehabilating hydro-plant. State Rv. Comn. has authorized the issuing of $375,000 in bonds.

N. J., Elizabeth—Peter J. Schweitzer, Inc., 994 Newark Ave., plans by W. Lehman, 972 Broad St., Newark, constructing 1 story, bsmnt., 90x150 ft. factory, Newark Ave. $100,000.

N. Y., Buffalo—Hambleton Terminal Corp., G. K. Hambleton, pres., River Rd., Tonawanda, plans constructing gasoline refinery, 5,000 bbl. daily capacity. $1,500,000. Engineer, c/o owner.

N. Y., Buffalo—Niagara Hudson Corp., Electric Bldg., plans constructing 100,000 kw. steam electric generating plant, city waterfront. Over $500,000. Dr. N. B. Gibson, ch. engr.

N. Y., East Rochester—Voted bonds constructing municipal electric plant. $360,000. L. C. Reynolds, 387 Castle St., Geneva, consult. engr. R. G. McDonald, village engr. and supt. P. Wks.

N. Y., Ogdensburg—State Dpt. Mental Hygiene, State Bldg., Albany, plans by W. E. Haugaard, State Bldg., Albany, constructing laundry and power plant. Over $500,000. T. F. Farrell, State Bldg., Albany, engr.

N. C., Wilson—Town plans special bond election Jan. 23, purchasing 7,500 kw. turbine for electric plant. $300,000. W. M. Wiggins, city mgr.

N. D., Grand Forks—Nodak Rural Electric Cooperative, Grand Forks, plans constructing electric power plant, Diesel engines. $225,000. Ellerbe & Co., 1100 Main Bldg., St. Paul, Minn., engrs.

O., Alliance—Ohio Pub. Serv. Co., 526 East Main St., Alliance, and Hanna Bldg., Cleveland, I. O. Kennedy, vice pres. and genl. mgr., plans remodeling Lake Park power plant, rebuilding turbine, installing coal and ash handling equipment, constructing power line improvements and extensions. $150,000.

O., Ashland—Ohio Pub. Serv. Co., J. R. Halladay, div. mgr., Ashland, and Hanna Bldg., Cleveland, plans constructing power plant improvements and additions and extensions to power lines. $60,000.

O., Dayton—Bids Jan. 25, by Con. Q.M., Wright Field, constructing test chamber superstructure, incl. tunnel duct structure, power building unit, 3 traveling cranes, rein.-con., structural steel, brick, concrete foundations. Extended date. Stone & Webster Eng. Corp., 49 Federal St., Boston, Mass., consult. engrs.

O., Dayton—Dayton Power & Light Co., Gas & Electric Bldg., soon lets contract constructing rein.-con. power plant extensions and alterations, except substructure work and power generating equipment. Columbia Eng. Corp., 4 and Plum Sts., Cincinnati, engrs.

O., Philo—Ohio Power Co., 305 Cleveland Ave. S.W., Canton, plans constructing plant improvements, incl. addition of an 85,000 kw. cross compound condensing unit, consisting of 1 high and 1 low pressure turbine generator. $6,500,000. Private plans.

O., Port Clinton—Ohio Pub. Serv. Comn., H. A. Cowgill, div. mgr., plans constructing line and power plant improvements for 1940. $80,000. Private plans.

O., Warren—Ohio Pub. Serv. Co., Warren, plans constructing power plant addition. $2,000,000. Private plans.

Okla., Oklahoma City—Oklahoma City Gas & Electric Co., F. J. Meyer, vice pres., 321 North Harvey St., plans installing several new substations, some underground feeder lines, here, some rural electric lines adjacent to Oklahoma City and Enid and the connection to several loops to insure continuity of service, by company forces. Total est. $1,631,104.

Okla., Sand Springs—Sand Springs Textile Mills, Sand Springs, plans constructing plant addition. $500,000.

Oregon—Pacific Power & Light Co., P. B. McKee, pres., Pub. Serv. Bldg., Portland, plans constructing 1,500 kw. addition to Pacific's Cove, Ore. power plant on Crooked River, near Bend, also constructing number substations and rehabilitation lines in Redmond area. $250,000.

Pa., Phila.—Pennsylvania Salt Mfg. Co., 1000 Widener Bldg., plans constructing plant on 50 acre tract, on Delaware River at Cornwells Heights. $2,000,000. Site purchased.

Tex., Baytown—Humble Oil & Refining Co. plans expansion program for refinery plants and steel tank farm. About $2,500,000.

Tex., Gainesville—J. B. Tanner, mayor, defeated bonds improving municipal electric light and power plant, extending lighting facilities and lines for industrial use, new plant equip. and machinery. $70,000.

Tex., Waco—Owens-Illinois Glass Co., Ohio Bldg., Toledo, O., plans constructing glass factory, concrete, steel, brick buildings, on 52 acre plant site on M. K. T. Ry., just outside city limits. About $1,000,000. E. W. McVeigh, const. engr., Alton, Ill.

Wash., Tacoma—Pennsylvania Salt Co. of Washington, Tide Flats, plans constructing new plant. $750,000.

Wash., Vancouver—Aluminum Co. of America, J. P. Growden, ch. hydraulic engr., Gulf Bldg., Pittsburgh, Pa., will construct alumina electrometallurgical reduction plant, initial output 15,000 tons yearly, on 180 acre tract along Columbia River, 2½ mi. south of here, by force account. Est. $3,000,000.

Wash., Walla Walla—Continental Can Co., 100 E. 42 St., New York City, plans constructing can manufacturing plant. $500,000. Site to be selected within 90 days. Maturity early summer.

Wisconsin, Illinois, Minnesota, North and South Dakota—Northern States Power Co. of Minnesota, R. F. Pack, pres. 15 South 5 St., Minneapolis, Minn., plans construction and improvement program; budgeted expenditure, $10,441,500, completing new steam plant at LaCrosse, Wis., and constructing new 67,000 hp. steam generating plant as addition to existing plant; additional transformer capacity in Minneapolis loop, new substation at Navarre and 11½ mi. 66,000 volt line connecting substation with Twin cities transmission loop, new 4,000 volt feeder from Marshall St. substation, additional equipment for Hiawatha, University, Main St. Excelsior and Waconia substations, above in Minneapolis, Minn. Div.; improving and constructing additions at Faribault, Mankato, St. Cloud, St. Paul and Stillwater, Minn., Fargo and Minot, N. D., Sioux Falls, S. D., Galena, Ill.

B. C., Westbank—Municipality making plans constructing power plant. $50,000. Private plans.

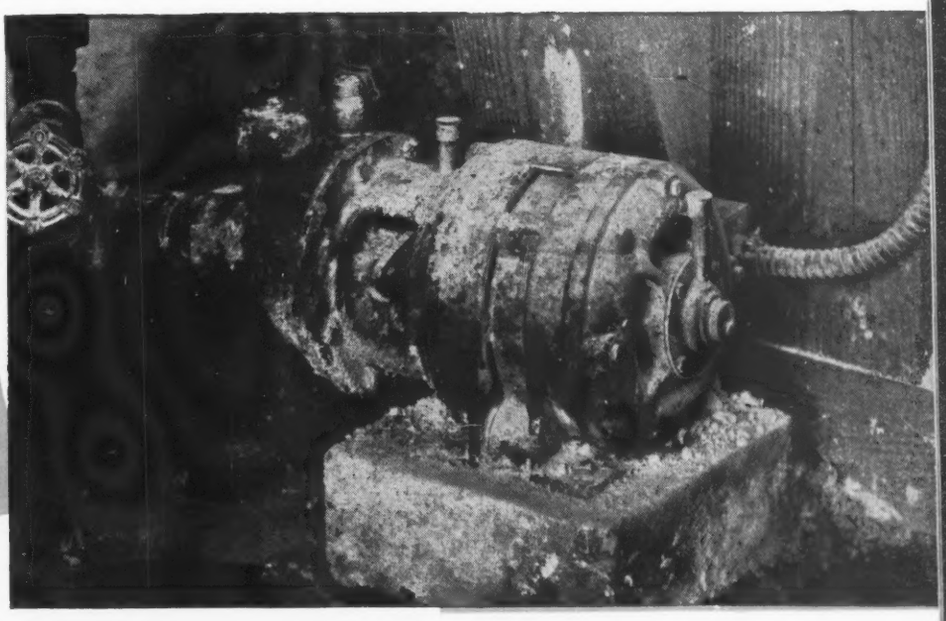
Newfoundland, Cornerbrook — Bowaters Paper Mill, Ltd., 121 Queen Victoria St., London, England, making plans constructing extensions to pulp and paper mills, increasing capacity by 30,000 tons per year. $2,000,000. Private plans.

Que., LaSarre—LaSarre Power Co., Ltd., LaSarre, making plans constructing hydro-electric development, bringing installation from 700 hp. plant on LaSarre River to 1,400 hp. Private plans.

NO PLACE FOR WEAKLINGS!

Here's an Amazing True Story of How 17 Allis-Chalmers Lo-Maintenance Motors Proved Their Low Maintenance Costs! Get the Facts on Full Measure Protection in Lo-Maintenance Motors, on the Savings It Means to You!

Another true case history from the Allis-Chalmers files that proves **"IT PAYS TO BUY THE EQUIPMENT THAT PAYS FOR ITSELF!"**



Operating where dust filled the air . . . fine chemical dust that bit like acid . . . that's a cruel test for any motor to pass! But it's the kind of test that brings out motor differences that might otherwise take months of normal operation to show up! And it's the kind of test that gives Allis-Chalmers Lo-Maintenance Motors a chance to prove their Full Measure Features!

There were 39 motors on the job in this large Southern chemical plant — 17 Allis-Chalmers and 22 of six other makes. All were operating under the same adverse conditions. But here's what the officials of the chemical company discovered when they checked repair and maintenance costs after two years of service!

For the 22 motors of other makes, the total upkeep cost was more than $500.00! But for the 17 Allis-Chalmers motors, the total repair bill was the sensationally low figure of $17.30!

Orders 18 More!

That's the reason this company ordered 18 additional motors . . . made Allis-Chalmers first choice in their plant! And that's the reason Lo-Maintenance Motors are fast becoming first choice in hundreds of plants throughout the country!

For when you buy a Lo-Maintenance Motor, you get more than a motor that delivers just a rated horsepower. You get a motor that has built into it the results of Allis-Chalmers' 90 years of advancing with industry . . . of making motors to meet the rigid requirements of their own famous line of heavy duty industrial equipment.

LOOKS BAD, DOESN'T IT? BUT THIS Allis-Chalmers Lo-Maintenance Motor—like the rest of the original 17 in this chemical plant — is still running as perfectly as the day it was installed . . . giving dependable daily service in motor-ruining chemical dust.

High carbon steel frame . . . indestructible rotor . . . husky all-around construction with no skimping materials . . . add them together and you get a motor that's built for long life . . . without running up costly repair bills!

Get the Full-Measure story on Lo-Maintenance Motors. Call the nearest Allis-Chalmers district office or write direct to Allis-Chalmers. Find out how you can cut maintenance . . . keep production steady . . . with Allis-Chalmers Lo-Maintenance Motors!

1030

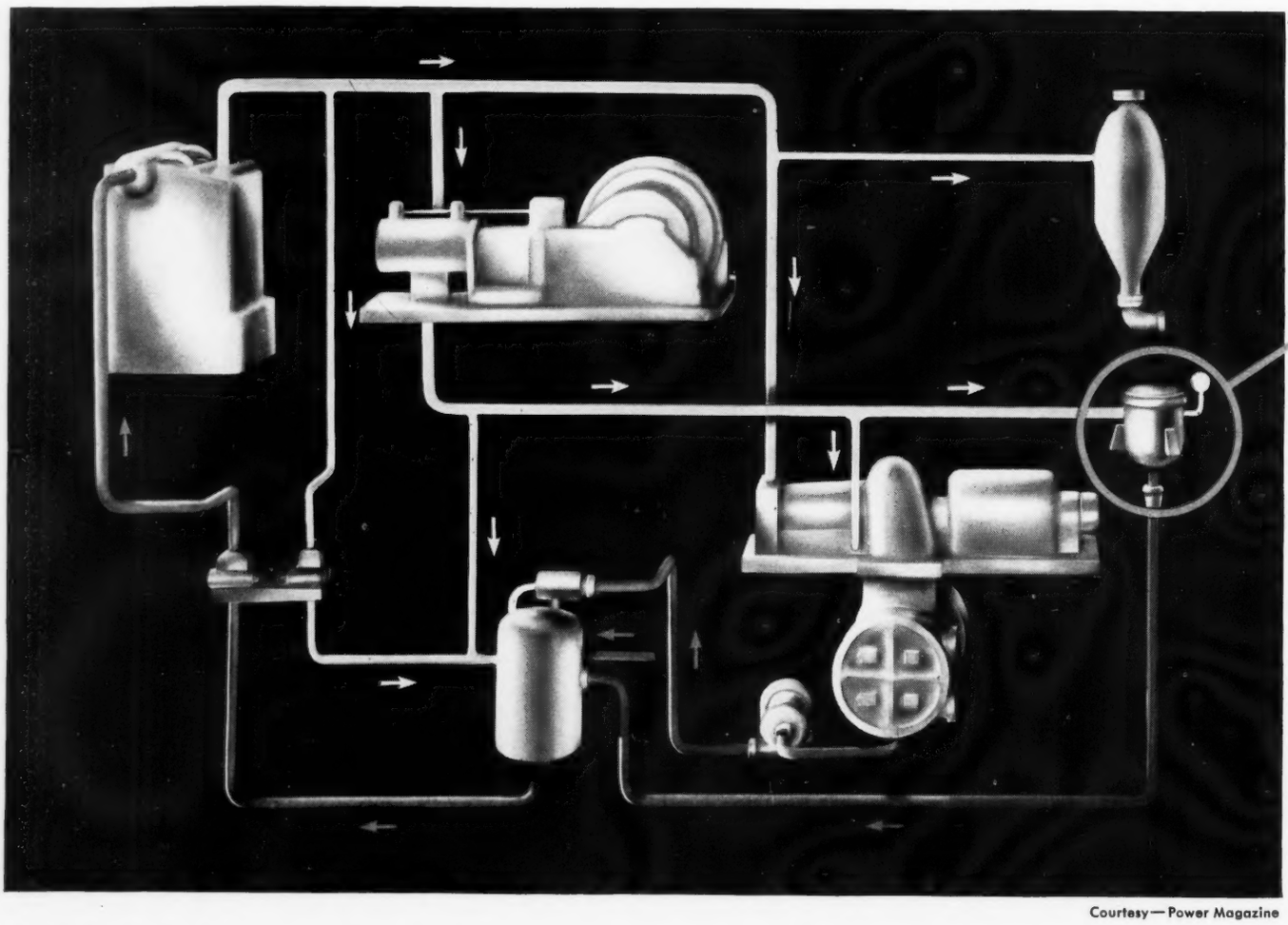
Over 90 Years of Engineering Superiority Work for You When You Specify Allis-Chalmers!

ALLIS-CHALMERS

MILWAUKEE · WISCONSIN

FROM *GOOD* POWER HOOKUPS

FOR L.P. PROCESS STEAM...



Courtesy—Power Magazine

HOOKUP #15 **Where low-pressure process load is highly variable, a mixed-pressure condensing turbine with a backpressure engine or turbine offers a flexible arrangement. The mixed-pressure unit takes steam at boiler or lower process pressure, or both. Such units suit plants where power load has outgrown process demands and a new prime mover is required for balance.**

ENGINEERS will recognize the diagram opposite as typical of many plants which process glue, gelatin or other similar products. In those plants where process load exceeds power demands, the reducing valve between main steam and process header operates continuously.

For the purpose of valve applications, a Pressure Cooker may be substituted for the Evaporator, or the Dryer may be a Rotary or Tunnel Type... but the principle of "Good Valve Practice" would remain the same.

Similarly, whether you select a globe, angle or gate valve, Jenkins sound Figure Number Recommendations would remain the same for *any* low pressure process steam system.

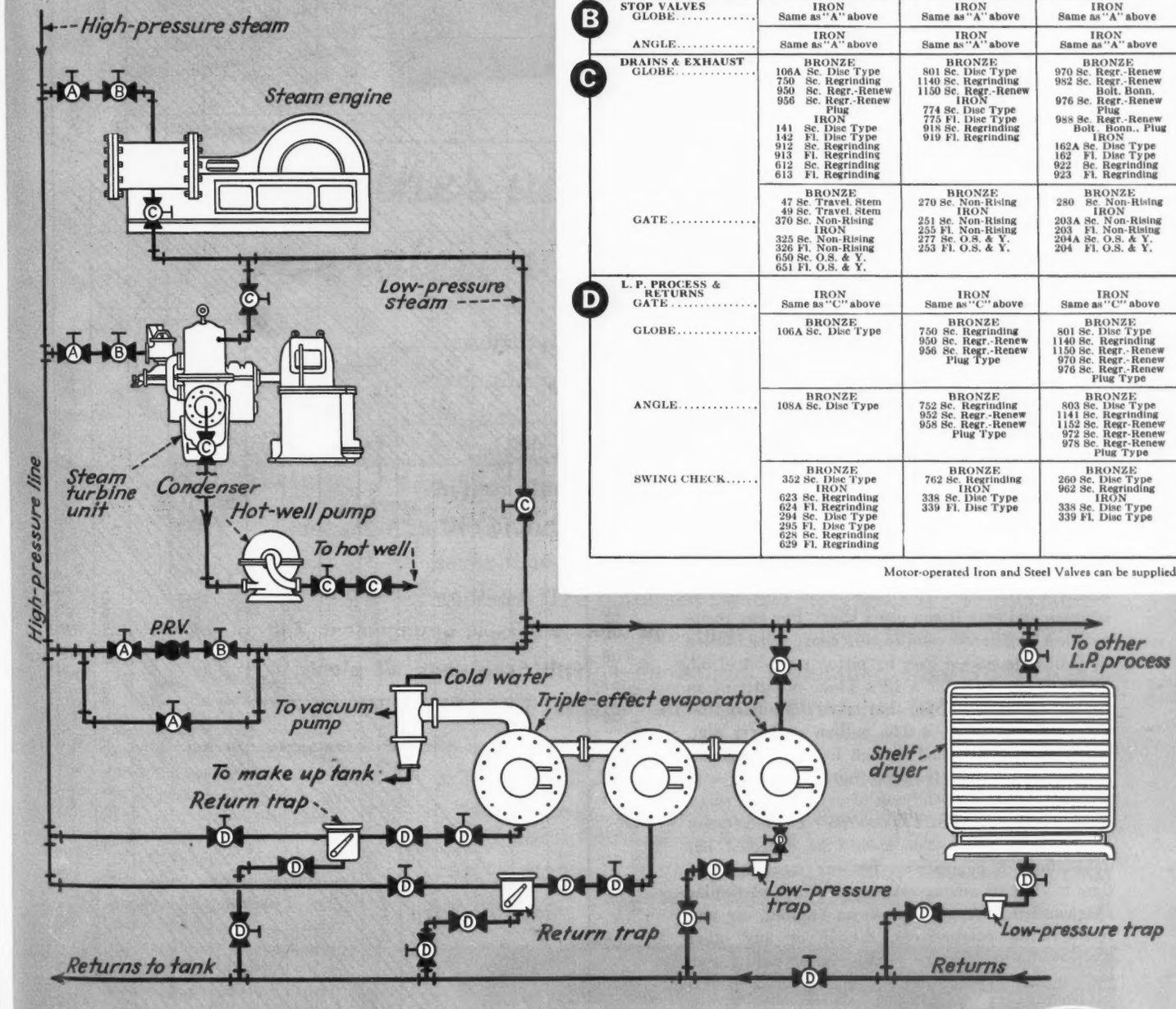
NEXT MONTH—AUXILIARY DRIVES

IN VALVES *Jenkins* GIVES YOU EVERYTHING

. . . TO *GOOD* VALVE PRACTICE

Jenkins RECOMMENDS . . .

STEAM CONNECTIONS FOR EVAPORATORS, DRYERS, ETC.



REFERENCE CHART TO JENKINS FIGURE NUMBERS FOR L. P. PROCESS STEAM

		Standard	Medium	Extra Heavy
A	STEAM SUPPLY GATE	IRON 651 Fl. O.S. & Y.	IRON 253 Fl. O.S. & Y.	IRON 204 Fl. O.S. & Y.
	GLOBE	IRON 142 Fl. Disc Type 913 Fl. Regrinding 613 Fl. Regrinding	IRON 775 Fl. Disc Type 919 Fl. Regrinding	IRON 162 Fl. Disc Type 923 Fl. Regrinding
	ANGLE	IRON 144 Fl. Disc Type 915 Fl. Regrinding 615 Fl. Regrinding	IRON 777 Fl. Disc Type 921 Fl. Regrinding	IRON 163 Fl. Disc Type 925 Fl. Regrinding
B	STOP VALVES GLOBE	IRON Same as "A" above	IRON Same as "A" above	IRON Same as "A" above
	ANGLE	IRON Same as "A" above	IRON Same as "A" above	IRON Same as "A" above
C	DRAINS & EXHAUST GLOBE	BRONZE 106A Sc. Disc Type 750 Sc. Regrinding 950 Sc. Regr.-Renew 956 Sc. Regr.-Renew Plug IRON 141 Sc. Disc Type 142 Fl. Disc Type 912 Sc. Regrinding 913 Fl. Regrinding 612 Sc. Regrinding 613 Fl. Regrinding	BRONZE 801 Sc. Disc Type 1140 Sc. Regrinding 1150 Sc. Regr.-Renew IRON 774 Sc. Disc Type 775 Fl. Disc Type 918 Sc. Regrinding 919 Fl. Regrinding	BRONZE 970 Sc. Regr.-Renew 982 Sc. Regr.-Renew Bolt. Bonn. 976 Sc. Regr.-Renew Plug 988 Sc. Regr.-Renew Bolt. Bonn., Plug IRON 162A Sc. Disc Type 162 Fl. Disc Type 922 Sc. Regrinding 923 Fl. Regrinding
	GATE	BRONZE 47 Sc. Travel. Stem 49 Sc. Travel. Stem 370 Sc. Non-Rising IRON 325 Sc. Non-Rising 326 Fl. Non-Rising 650 Sc. O.S. & Y. 651 Fl. O.S. & Y.	BRONZE 270 Sc. Non-Rising IRON 251 Sc. Non-Rising 255 Fl. Non-Rising 277 Sc. O.S. & Y. 253 Fl. O.S. & Y.	BRONZE 280 Sc. Non-Rising IRON 203A Sc. Non-Rising 203 Fl. Non-Rising 204A Sc. O.S. & Y. 204 Fl. O.S. & Y.
D	L. P. PROCESS & RETURNS GATE	IRON Same as "C" above	IRON Same as "C" above	IRON Same as "C" above
	GLOBE	BRONZE 106A Sc. Disc Type	BRONZE 750 Sc. Regrinding 950 Sc. Regr.-Renew 956 Sc. Regr.-Renew Plug Type	BRONZE 801 Sc. Disc Type 1140 Sc. Regrinding 1150 Sc. Regr.-Renew 970 Sc. Regr.-Renew 976 Sc. Regr.-Renew Plug Type
	ANGLE	BRONZE 108A Sc. Disc Type	BRONZE 752 Sc. Regrinding 952 Sc. Regr.-Renew 958 Sc. Regr.-Renew Plug Type	BRONZE 803 Sc. Disc Type 1141 Sc. Regrinding 1152 Sc. Regr-Renew 972 Sc. Regr-Renew 978 Sc. Regr-Renew Plug Type
	SWING CHECK	BRONZE 352 Sc. Disc Type IRON 623 Sc. Regrinding 624 Fl. Regrinding 294 Sc. Disc Type 295 Fl. Disc Type 628 Sc. Regrinding 629 Fl. Regrinding	BRONZE 762 Sc. Regrinding IRON 338 Sc. Disc Type 339 Fl. Disc Type	BRONZE 260 Sc. Disc Type 962 Sc. Regrinding IRON 338 Sc. Disc Type 339 Fl. Disc Type

Motor-operated Iron and Steel Valves can be supplied.

JENKINS BROS., 80 WHITE STREET, NEW YORK, N. Y.

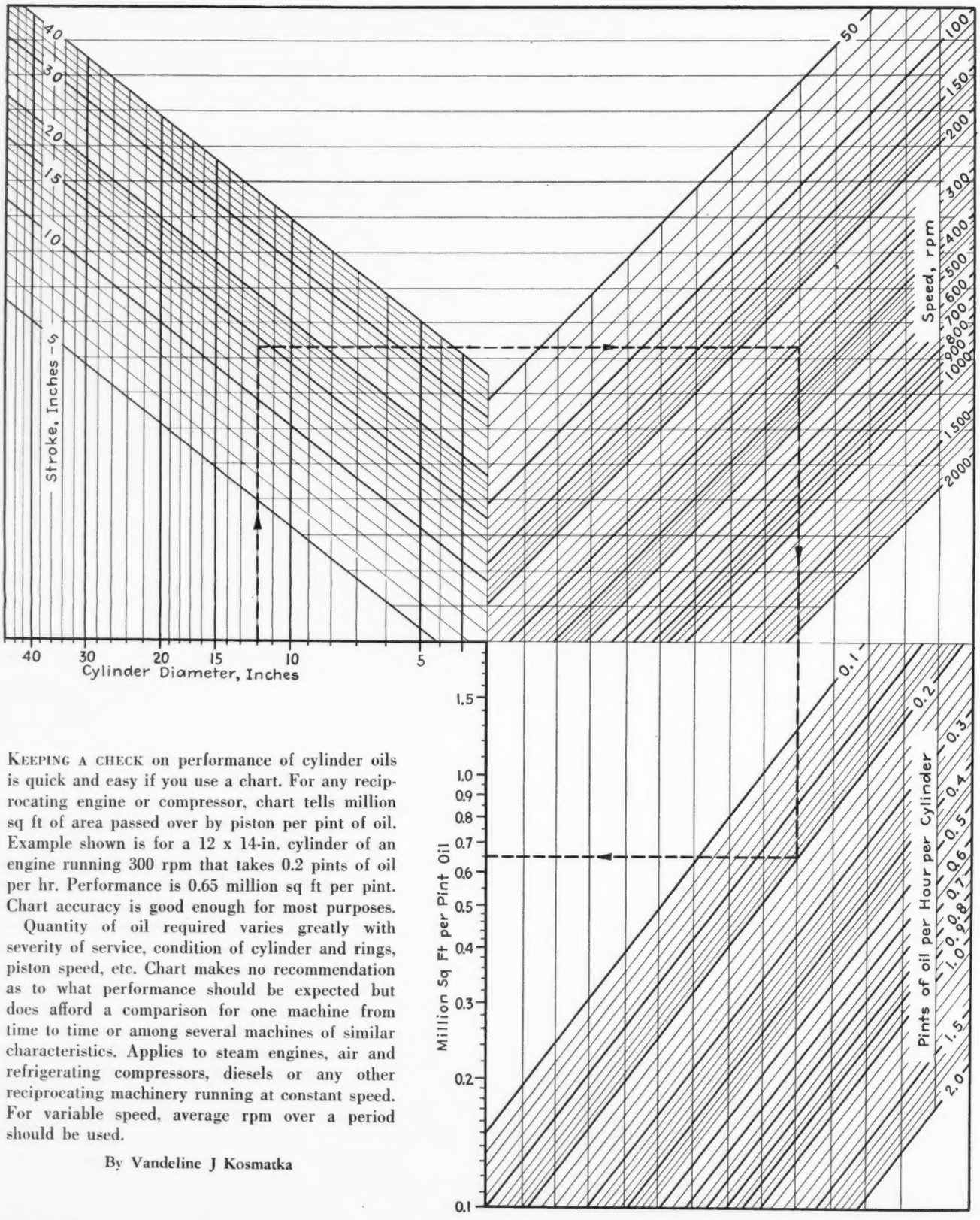
Bridgeport • Boston • Chicago — Philadelphia • Atlanta • Houston

TRADE JENKINS MARK — Jenkins Bros.

#15 OF A SERIES designed to help in your selection of JENKINS VALVES

Number 91

Cylinder-Oil Lubrication Chart



KEEPING A CHECK on performance of cylinder oils is quick and easy if you use a chart. For any reciprocating engine or compressor, chart tells million sq ft of area passed over by piston per pint of oil. Example shown is for a 12 x 14-in. cylinder of an engine running 300 rpm that takes 0.2 pints of oil per hr. Performance is 0.65 million sq ft per pint. Chart accuracy is good enough for most purposes.

Quantity of oil required varies greatly with severity of service, condition of cylinder and rings, piston speed, etc. Chart makes no recommendation as to what performance should be expected but does afford a comparison for one machine from time to time or among several machines of similar characteristics. Applies to steam engines, air and refrigerating compressors, diesels or any other reciprocating machinery running at constant speed. For variable speed, average rpm over a period should be used.

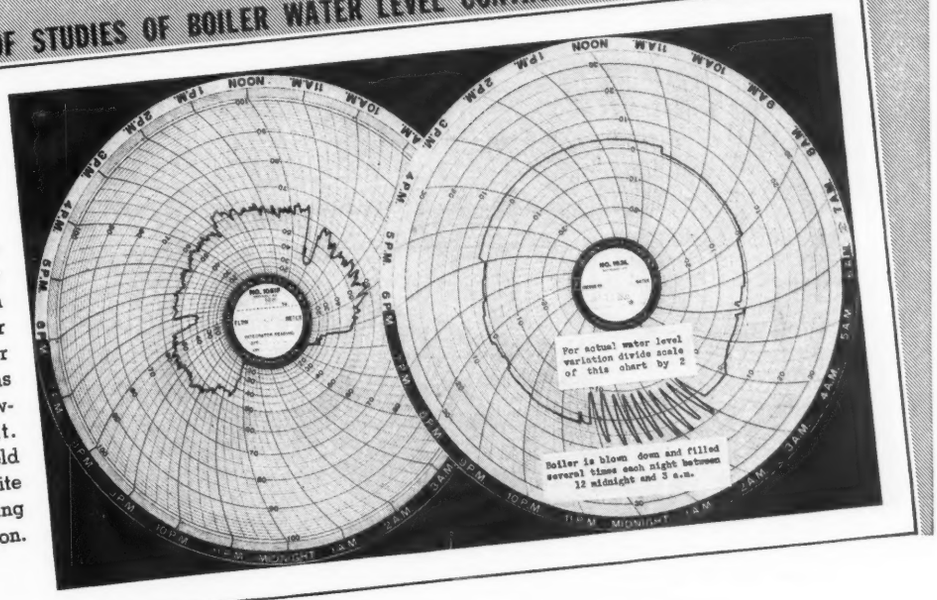
By Vandeline J Kosmatka

© POWER

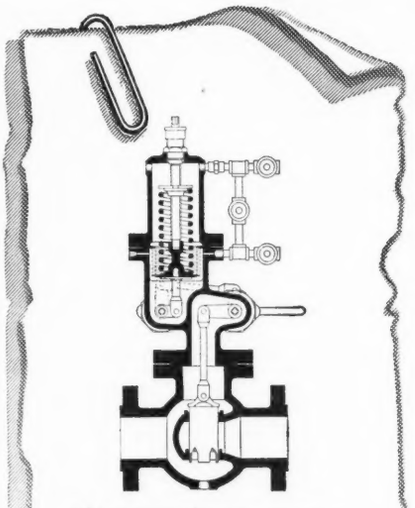
NO. 1 IN A SERIES OF STUDIES OF BOILER WATER LEVEL CONTROL WITH COPES FLOWMATIC

150 POUNDS W. S. P.

150-lb. 500-deg. Vogt Class M Bent-Tube Boiler fired by powdered coal. Loads from 30,000 to 67,000 lb. per hour during day; 10,000 lb. per hour at night. Two blowdowns through each of five blowdown valves each night. Otherwise, water level is held within about 2 inches. Write for Bulletin 423 describing this interesting installation.


For actual water level variation divide scale of this chart by 2
Boiler is blown down and filled several times each night between 12 midnight and 3 a.m.

★ "No other unit in our plant has operated with less attention"



Many types of pump governors are used with the more than 36,000 COPES Feed Water Regulators now in service. But none we've seen have given better results than the COPES Type SDS-2. Designed for remote control of excess pressure. Engineered for the individual installation. Built for long life, and delivering it in hundreds of plants. For better pump control, insist on the Type SDS-2. Write for Leaflet P7-A.

Results in this plant emphasize two good reasons why the swing is to the COPES Flowmatic for effective feed water regulation in modern steam plants. Close water level control under all load conditions increases safety and permits higher efficiency. Trouble-free operation—this user says, "No unit in our plant has operated with less attention"—saves time in the boiler room and saves money in maintenance. The simplified steam-flow type COPES Flowmatic is giving results like these in plants from 80 to 1325 pounds W.S.P.—on boilers generating from 15,000 to 550,000 pounds per hour. Write for Bulletin 409-B.

NORTHERN EQUIPMENT CO., 201 GROVE DRIVE, ERIE, PA.

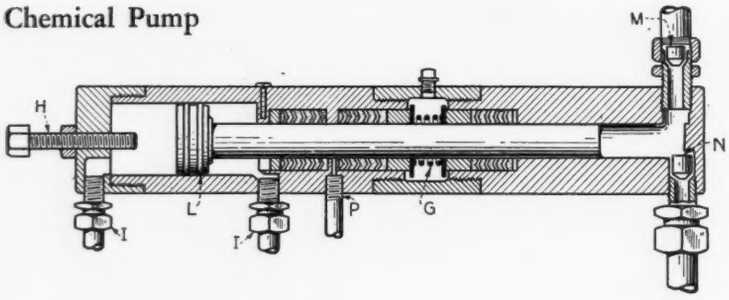
Feed Water Regulators, Pump Governors, Differential Valves
Liquid Level Controls, Reducing Valves and Desuperheaters

BRANCH PLANTS IN CANADA, ENGLAND, FRANCE, GERMANY AND ITALY
REPRESENTATIVES EVERYWHERE

★ GET CLOSER LEVEL CONTROL WITH THE COPES FEEDS BOILER ACCORDING TO STEAM FLOW-AUTOMATICALLY FLOWMATIC ★ REGULATOR

What's New In Plant Equipment

Chemical Pump



NELSON "SYNCHRONIZED"-DRIVE pumps have no auxiliary motors, levers, cams, or driving meters. Synchronization may be obtained for chemical pump propulsion wherever a reciprocating pump is used on the untreated solution, the pressure drop across either cylinder of the main pump supplying the chemical pump with only motivating force it requires. Pressure takeoffs from each end of either the power or fluid cylinder of the main pump connects to comparable cylinder in the chemical pump through ports *I*. Any change in the pumping rate of the main pump simultaneously changes the pumping rate of the chemical pump, giving accurate ratio proportioning without auxiliary rotors or meters. Stroke adjustment by means of screw *H* permits varying the chemical volume at will. Spring tension packing glands *G* eliminate usual packing nuts, automatically taking up the packing wear. Hole *P* gives visual indication when new packing is needed. Poppett-type valves *M* and *N* open and shut on pump pressure and suction alone, eliminating springs and valve rods.

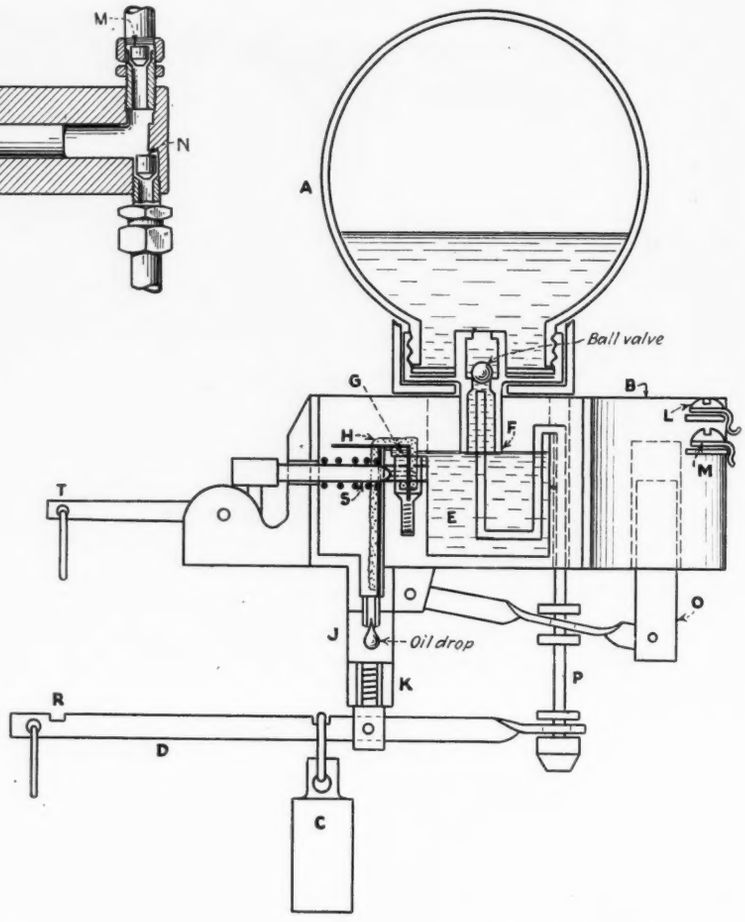
D W Haering & Co, Inc, 2306 S Winchester Ave, Chicago, Ill.

Chill Ring

WEDGE BACKING or chill ring said to simplify welding operation. Spacing bead in center of ring gives joint of uniform width, while with ring, operator can penetrate

to the inside of the pipe with first layer of weld metal. This is said to eliminate main cause of weld failure in pipe welding.

Wedge Protectors, Inc, 9546 Richmond Ave, Cleveland, Ohio.



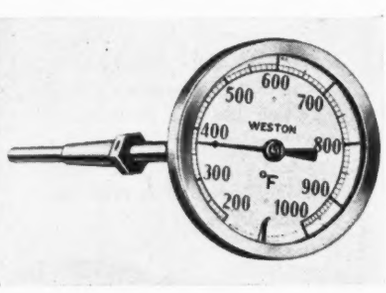
Lubricator

"MYKROFEED" lubricator is designed to get oil by gravity, under controllable flow, from a transparent, air-tight, Lucite reservoir, *A*, to bearings (see drawing). Ball valve closes the reservoir and is opened by a pin actuated by solenoid *B* or by hand. The latter is done by moving weight *C* to the notch *R* in lever *D*, chain on the end of lever facilitating operation if necessary. When valve is open, oil falls into constant-level chamber *E* until the level rises and liquid-seals the outlet at *F*. When this point is reached, flow stops, even if the valve is still open. Shallow trough *G* in which the feed wicks, *H*, lie, connects to chamber *E*. Oil level in *E* is on a line slightly higher than bottom of trough *G* to keep the wicks saturated with oil. Sight-feeds *J* show rate of feed. Brass fittings screwed into tapped holes *K* take copper tubing connecting lubricator with bearings. For electrical operation, solenoid terminals *L* and *M* are connected to machine's motor leads. Then, when machine switch is closed, solenoid plunger *O* pulls up pin *P*, lifting ball valve off its seat. When switch is opened, plunger *O* and pin *P* drop of their own weight, closing the valve. Ordinarily used only after a long shutdown period when bearings need more lubrication, self-closing valve *S* is held open by holding down lever *T*. Oil then by-passes wicks and goes directly to bearings. Lubricator handles all oils up to 2000 sec Saybolt. As much as 50% variation in feed rates is obtainable without adding or removing wicks. This is done by raising or lowering wick unit in its well by a screw in bottom of the well.

Bromley & Son, 232c Chestnut St, Kearny, N. J.

Stack Thermometer

FLUE-GAS temperatures can be measured by fitting all-metal thermometer into sleeve holder, which in turn holds thermometer stem in horizontal position in center of flue-gas stream. Stem is 9 in. long, scale glass is shatterproof, and thermometer has temperature range from 200 to 1000 F, ac-



The Case* of CONDENSATE THAT CRIPPLED

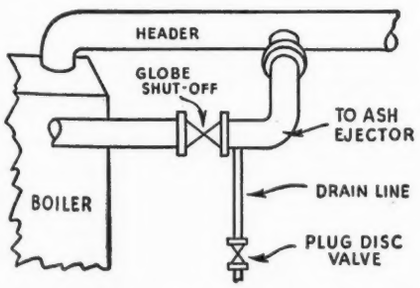
SOLVED WITH PREVENTIVE MAINTENANCE

"I'm sick of this condensate problem!" moaned the BIG BOSS. "Some day it will wreck our plant!"

"That valve seat is cut to pieces," said the ENGINEER, ". . . and we just put it into the line."

"Preventive Maintenance," offered the CRANE REPRESENTATIVE, ". . . with the right equipment should stop the trouble. Let's have a look!"

WE don't know that such conversation ever took place, but it might well have, in view of the facts of the case. In the power plant of a hosiery mill, steam was piped to an ash ejector, direct from the main header. There was some 12 or 14 feet of 2½" pipe between the header and the ejector line shut-off valve, as shown in the sketch below.



As a result, there always was a leg of condensate ahead of the valve. Each time the valve was opened, the severe cutting action of the water traveling at high velocity did serious damage to its seating surfaces.

Ordinary maintenance was useless. This globe valve was everlastingly being repaired or replaced. The Engineer saw that Preventive Maintenance—as suggested by G.W.H., the Crane Man—was necessary. Together they attacked the trouble at its source.

Preventive Maintenance counseled the installation of a small drain line with a Crane plug disc valve through which the condensate could be drained before the globe valve was opened. This was done.

Results: (1) The trouble was entirely eliminated. (2) The life of the globe valve was extended manifold. (3) Another user of piping equipment learned the economy of Preventive Maintenance, and of looking to Crane for the right valves and fittings for every need, common or extraordinary; also, of the wisdom of calling in the Crane Man on every flow control problem.

**This case is based on an actual experience of a Crane Representative in our Indianapolis Branch.*

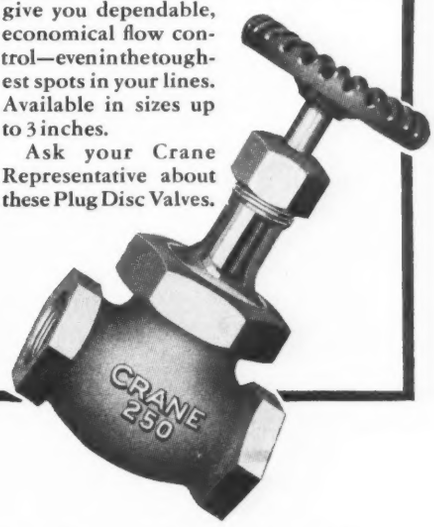
FOR TOUGH THROTTLING JOBS USE CRANE PLUG DISC VALVES

For throttling and other severe piping jobs at pressures from 150 to 350 pounds steam at 550°F., you can't make a better choice than Crane Brass Plug Disc Valves.

The extra stamina of these Crane valves is in their disc and seat metals—just the right combination for highest resistance to wire-drawing, erosion and corrosion under actual working conditions. The same care in the selection of body materials, sound design, extra strength and perfect balance in every part, result in valves from which you may expect unusual performance.

In services up to 250 pounds steam pressure, this Crane No. 212P will give you dependable, economical flow control—even in the toughest spots in your lines. Available in sizes up to 3 inches.

Ask your Crane Representative about these Plug Disc Valves.



CRANE

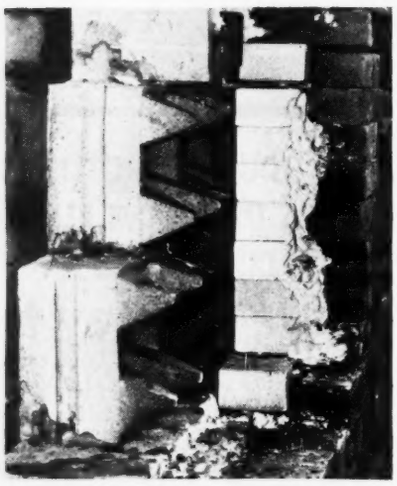
CRANE CO., GENERAL OFFICES
836 S. MICHIGAN AVE., CHICAGO
VALVES • FITTINGS • PIPE
PLUMBING • HEATING • PUMPS

curacy guaranteed by maker within 1%. For installation it is necessary to drill $\frac{5}{16}$-in. hole in pipe, insert tapered sleeve holder until it fits tight, then slip thermometer stem through sleeve.

Weston Electrical Instrument Co, 614 Frelinghuysen Ave, Newark, N. J.

Air-Cooled Walls

PYRAMID-TYPE walls used for oil- or pulverized coal-fired furnaces. Consists of panels of specially designed refractory block having a group of pyramids on its rear face, to increase the cooling-surface area. These blocks provide an air space at the rear; entire units are fitted with iron anchors and tie links. Made up of two courses of blocks, and one course of slotted header blocks, unit interlays with

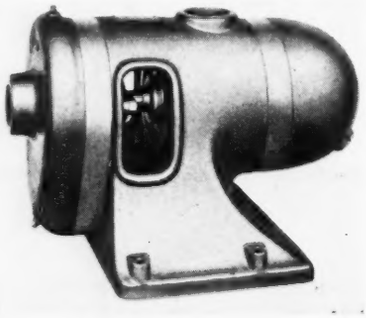


standard 9-in. firebrick courses. Continuous circulation of air draws off objectionable heat conducted through furnace walls. Although principal advantage of blocks is claimed to be in saving of refractory maintenance, preheated air circulated behind blocks may be returned to the furnace by ducts.

McLeod & Henry Co, 31 Monroe St, Troy, N. Y.

Centrifugal Pump

SMITHWAY is combination of fully enclosed, self-protected electric motor with centrifugal pump in single frame. Manufacturer claims that unit provides smallest size-to-

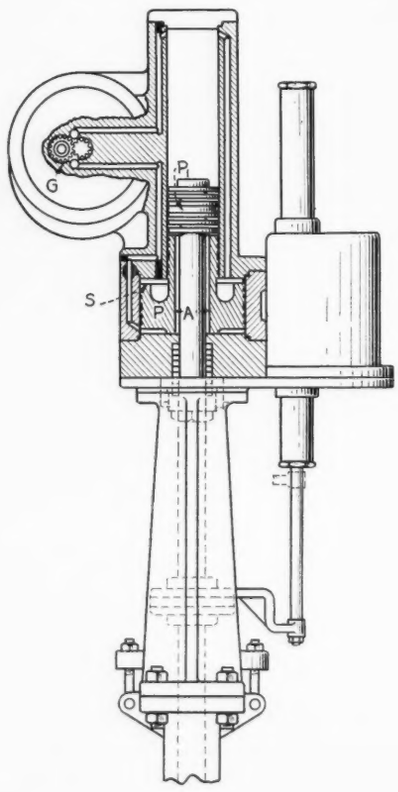


power and highest power-to-weight ratio of any motor operating on standard-cycle, 3-phase current. Pump is constructed so that water or other liquid pumped passes through thin tubular shell of motor, providing continuous cooling. Powered with tubular-type motor of from ½ to 10 hp, Smithway handles from 20 to 200 gpm, operates against heads up to 250 ft.

Smith Meter Co, Los Angeles, Calif.

Hydraulic Valve Operator

HYDRAULIC valve operator comprising motor-driven gear pump *G* and tandem pistons *P* and P_1 acting directly on the valve stem, eliminates all gear reductions (see drawing). All space in hydraulic system and small reservoir on pump filled with oil. At start of stroke to open valve, fluid is pumped under large piston *P* and a large thrust is developed to unseat valve. The large piston seats at *S* after traveling far enough to unseat the valve. Fluid then passes up annular passage *A* under small piston P_1, which exerts sufficient thrust to complete the gate movement at a faster rate. On the opening stroke, valve motion is stopped by a limit switch opened by motion of the

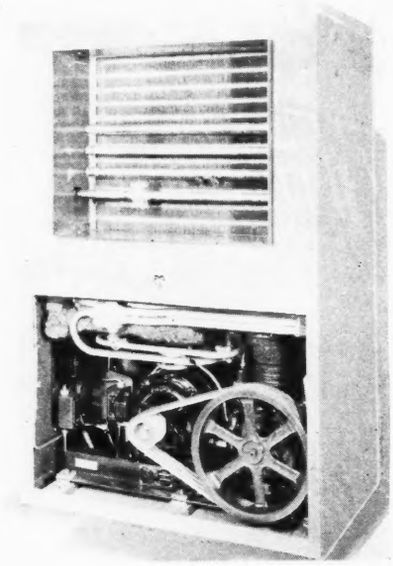


valve when it gets near limit of travel. The valve is closed by reversing the pump to deliver fluid on top of the piston P_1. As the valve reaches the end of its stroke a pressure is built up that insures a tight seal, when a pressure switch opens to stop the pump motor. If pressure switch fails, a slight increase in pressure opens the relief bypass valve and permits the motor to operate without creating excessive pressure. There is no motor stalling and no excessive forces applied to any part of the valve or its operating mechanism. Actuator can be applied to any type of gate valve or to similar operations.

Iohn S Barnes Corp, Rockford, Ill.

Booster-Type Conditioner

ORIGINALLY developed for installation in industrial air-conditioning system where more cooling was needed than a certain duct was able to deliver at times, booster-type conditioner is installed as integral part of duct. Lengths of pipe extending across face of finned coil, see cut, are provided for superheating suction gas

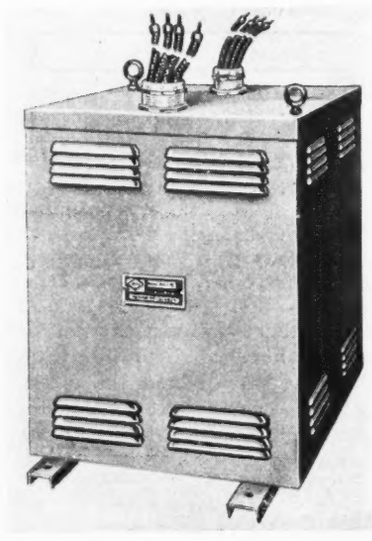


before it reaches the compressor. If it is impossible to install unit in duct, bypasses can be supplied to send part or all of the air through coils of the booster.

Frick Co, 325 Broadway, Waynesboro, Pa.

Air-Cooled Transformers

LINE of transformers is now manufactured in 15 and 25 kva. These ratings can be supplied in insulated types, with primary voltages of 575, 230/115 or 460/230 and secondary voltages of 230/115. Manufacturer claims high full-load operating effi-



ciency is maintained through design and construction features such as full air draft ventilation, specially wound, hand-finished

REGISTERED PROFESSIONAL
CHEMICAL ENGINEERS

CABLE ADDRESS "BETZPHIL" BENTLEY CODE

W. H. & L. D. Betz

CHEMICAL ENGINEERS AND CONSULTANTS ON ALL WATER PROBLEMS

GENERAL OFFICES AND LABORATORIES-235 W. WYOMING AVENUE
PHILADELPHIA, PENNSYLVANIA

ansing,
ank Corporation,
Ohio

Dear John:

You certainly did have a bad carry-over condition. I am glad to hear that you now can operate at such greatly increased ratings and with so little blowdown.

But don't thank me. The credit belongs to our chemical engineers, whose recent research shows the way to conquer difficult foaming cases with Reactive Colloids. Yes, it usually requires only a few parts per million to accomplish astonishing results.

We will be glad to send complete data covering our various other successful applications to your friend, Mr. Jordan, (or anyone else troubled with impure steam). As you know, we have a great wealth of convincing evidence.

Wishing you best of luck with your "New" Boilers, as you call them, I remain

Sincerely,

W. H. & L. D. BETZ

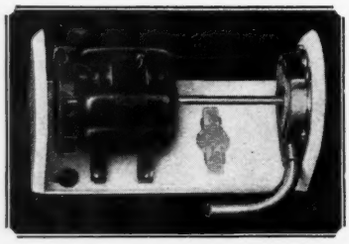
Jas. K. O'Br

coils, insulated between layers with high dielectric strength materials, and cores of thin-gage low-loss steel.

Acme Electric & Mfg Co, Cleveland, Ohio.

Acid-Resisting Pump

STAINLESS-STEEL pump is mounted on vitreous enameled stand, and is available in 3 sizes ranging from 140 to 360 gph. Fea-



tures include new type fan which pulls air through motor, self-aligning bearings, moisture-resisting stator coils and a tube outlet plated with block tin inside and out.

Air-O-Line Co, Dallas, Texas.

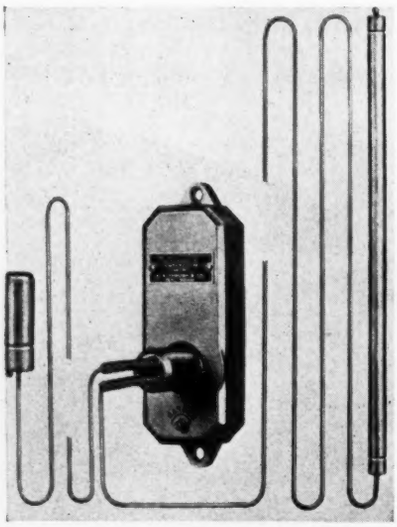
Strip Heaters

DESIGNED for operation at sheath temperatures as high as 1200 F, heaters are enclosed in porcelain-enamel steel casings. Units said to substantially reduce replacement costs in heavy-duty applications due to resistance to corrosion.

General Electric Co, Schenectady, N. Y.

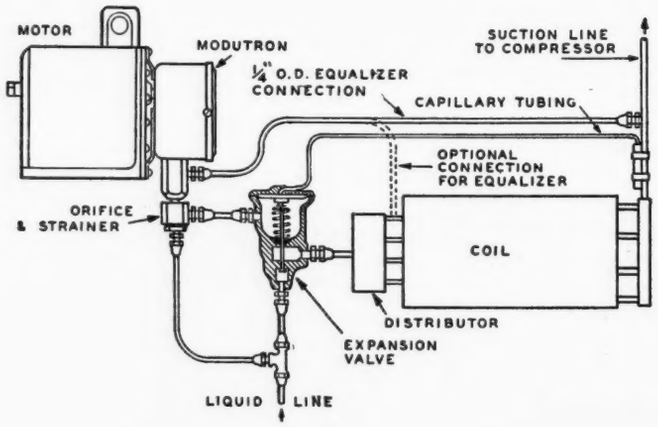
Temperature Control

DIFFERENTIAL temperature control is designed for use with maker's forced-circulation hot-water heating system. Unit said to balance outdoor and indoor temperatures



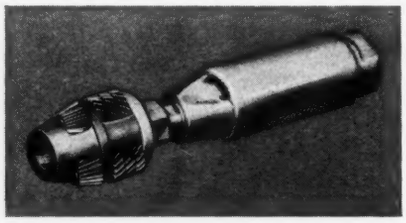
in single or groups of industrial buildings. One bulb is placed outside and the other inside, and when heat is necessary, control automatically operates other mechanism to start production of more heat.

H A Thrush & Co, Peru, Ind.



Tube Cleaners

E P SERIES are 6-bladed, 2-cylindered air motors in which power developed is said to be increased because of 6 overlapping power impulses per revolution. Unique method of admitting air into cylinders assures positive starting, high torque and

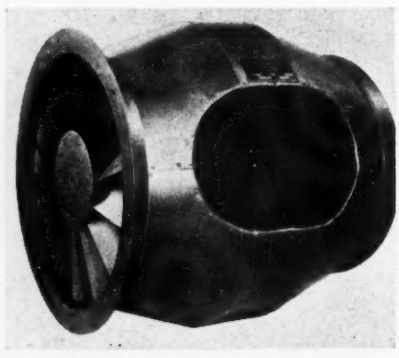


elimination of sticking due to the incoming air holding the blades in close contact with the cylinder wall. Permanent seal between intake and exhaust areas of opposing cylinders insures continuation of original efficiency, according to manufacturer.

Thomas C Wilson, Inc, 51 Vandam St, New York, N. Y.

Ventilating Unit

"BIFURCATOR" is designed to remove corrosive, toxic, high temperature and hazardous fumes. Consists of axial-flow pressure fan mounted in patented housing with motor set in separate built in chamber, iso-



lated from air flow. Can be installed as an integral part of the duct system without directional change in air flow. Available in sizes from 8 to 48 in.

DeBothezat Ventilating Equipment Div, American Machine & Metals, Inc, East Moline, Ill.

Air-Conditioning Control

"MODUTRON" system can be applied to any refrigeration installation using thermostatic expansion valves with customary external equalizer. Small electrically-operated valve is installed in equalizer line of expansion valve. Electric motor which operates valve is modulated by temperature, humidity, pressure or other condition to be controlled and opens the valve wide when maximum cooling is desired. If less cooling effect is needed, electric motor moves the valve to a more closed position, reducing effect of external equalizer on expansion valve. Since inlet pressure to coil will be higher than outlet pressure, expansion valve is then affected by a higher pressure than when system is wide open. This is due to pressure drop through distributor and coil. Usually only equalizer line is disturbed when controller is installed, so it can be added to existing systems for modernization as easily as on new installations.

Minneapolis-Honeywell Regulator Co, 2747 Fourth Ave, S, Minneapolis, Minn.

Hard-Facing Rod

HAYNES "93" hard-facing rod is recommended for use where severe abrasion, with only a moderate amount of impact, is met. Contains chromium, molybdenum, cobalt, has tensile strength of 43,000 lb psi, and hardness, as deposited by oxy-acetylene welding, of 62 Rockwell C. When deposits are heat-treated by heating to 1950 F, and then air cooling, the hardness reaches 66 to 67 Rockwell C.

Haynes Stellite Co, 30 East 42nd St, New York, N. Y.

Fuel Treatment

"LIQUID KLEEN-FLO" claimed to render catalytic effect on combustion, and is said to improve fuel oil by reducing its surface tension. Solution is added down fill line to the fuel in ratio of one gal. to every 2000 of fuel oil added to storage tank prior to its delivery. Said to combine chemically with moisture content in mechanical suspension in the oil body, forming new combination of hydrocarbons that disperse throughout and burn in the

(Continued on page 138)

Cost of replacing a broken-down 4" steel main in a steam distribution system would have cost the Connecticut Light & Power Co. $2344, including new variators, anchors, excavating and road re-surfacing. Unique use of American Metal Hose cut this to $1224 or a saving of $1120.

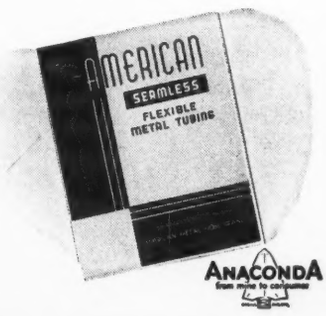
Underground steam distribution system repaired at saving of $1,120

Flexible bronze steam hose and Yankee ingenuity save expense of excavating 364 feet of broken-down steel main

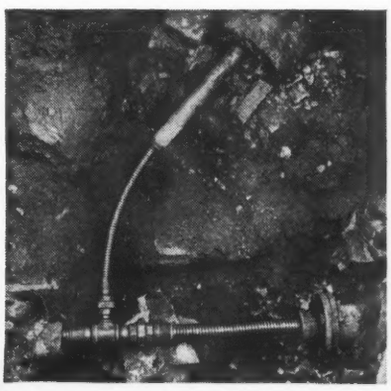
ALTHOUGH American Metal Hose has supplied flexible metal hose and seamless flexible tubing for many curious purposes, Connecticut Light & Power Company's use of steam hose to repair their steam distribution system is one of the most ingenious.

Less spectacular, perhaps, but just as important are thousands of other applications of flexible metal hose and seamless tubing—each serving dependably in the conveyance of air, gas and liquids of all kinds, sometimes under pressure, most times under gruelling conditions.

So, next time you are confronted with a difficult connector problem, investigate American Metal Hose and Seamless Flexible Metal Tubing. Engineers with over 30 years of experience, will help you select the right material. Meanwhile, be sure to read our new booklet, SS-25. Write for your copy. 40238



Excavations were made at four service points. Then 2½" and 2" bronze steam hose was drawn through the existing 4" steel main—less than a half day's work. Sections were connected with brass fittings, tees, nipples and unions. No expansion joints were used in the entire length. When steam was turned on, no lateral expansion was noticeable.



From the tees, sections of 1¼" flexible bronze hose was run through the old 2" services to back of walk and connected to the old service. Says Engineer Gardner of the utility: "Since making this installation, we have used this flexible bronze hose through leaking services under concrete roads with very substantial savings."

American Metal Hose

THE AMERICAN BRASS COMPANY, *General Offices:* Waterbury, Connecticut

In Canada: Anaconda American Brass Ltd., New Toronto, Ont. • *Subsidiary of Anaconda Copper Mining Co.*

Half Right . . .

A while ago, I was talking with the chief of a firetube boiler plant. Laughing fit to kill, he told me how one of his firemen had figured out a simple way to clean tubes. He filled a 2-quart fruit jar with gasoline, screwed the top on loose, tossed it in the open firedoor, slammed the door and ran! The resulting boom blew all the soot up the stack. His boss thought it was funny—forgetting that if the explosion started real trouble he'd be responsible.

That's a kind of a serious example, but too darn many of us pull similar crazy stunts, or let somebody working for us pull 'em. When I was an apprentice machinist, horseplay went on all the time. We never stopped to think of what might happen, until somebody got hurt.

In a plant only a couple of miles away, one apprentice tickled another while he was grinding with a thin wheel. The wheel jammed, burst, and the tickled apprentice went to the hospital. I still claim that the fault in that case was partly the foreman's—he should have stopped the practical jokes even if somebody did think he was a "sourpuss".

The foreman in this case, and the engineer in the first one, were the responsible people involved. They knew—or should have known—what could happen. Their fault lay in letting the man under them get away with dangerous tricks. They let the little things go, and then when the big one happens, their alibi is, "I didn't know it was loaded."

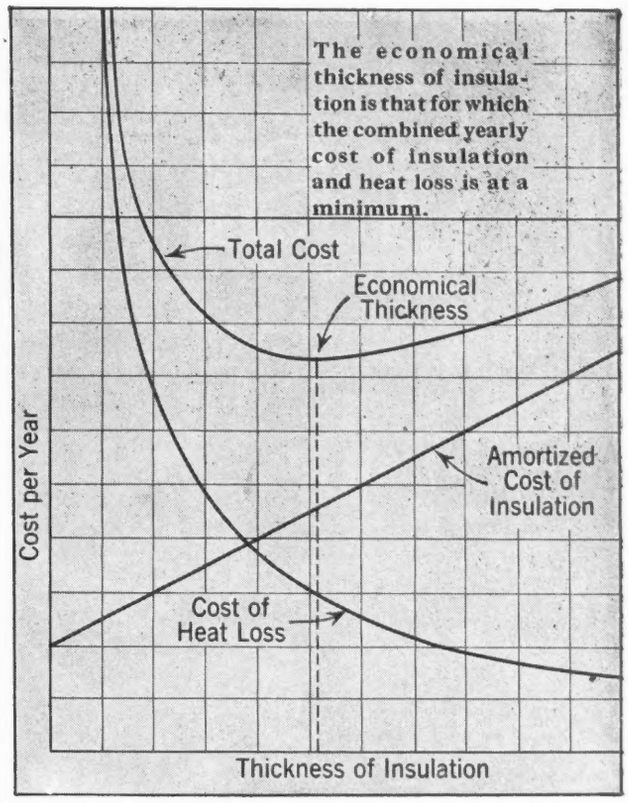
It's just as dangerous to allow half-right ideas to keep alive. It's obvious that somebody using a grinder should wear goggles, or that a welder should be shielded. But it should be just as obvious to every man working for you that certain valves *must* be kept open and certain doors shut, that you don't touch a chunk of iron to see if it's hot (but spit on it instead), or believe that a steam leak can always be found by passing a hand along the pipe. If any idea like that exists in your crew—it's your fault, not the crew's.

George Edwards

Engineer

No opinions so fatally mislead as those that are not wholly wrong, as no watches so effectually deceive the wearer as those that are sometimes right. —COLTON.

How to SAVE THE MOST MONEY with INSULATION


The economical thickness of insulation is that for which the combined yearly cost of insulation and heat loss is at a minimum.
Total Cost
Economical Thickness
Amortized Cost of Insulation
Cost of Heat Loss
Cost per Year
Thickness of Insulation

Make sure all your equipment is insulated with the *correct materials* in the *one correct thickness* that combines maximum operation efficiency with minimum heat waste

WHETHER or not your insulation is a paying investment depends entirely on the materials used and the amount applied. *Too much* will never pay an adequate return . . . *too little* results in heat losses that build up excessive fuel bills. But proper insulation, properly applied, will avoid both these costly mistakes. And a J-M Engineer will be glad to work out the most economical application.

Let him go through your plant and make a thorough study of your requirements. He'll give you the benefits of all the knowledge and data that Johns-Manville has accumulated during 81 years of research and practical experience on insulation problems. He can show you—from the complete line of J-M Insulations in brick, block and pipe-covering form—what materials are best suited for all your equipment. He can tell exactly how much insulation you can profitably use, and his recommendations will point the way to worth-while reductions in your fuel costs.

J-M Insulation Engineers have saved many individual plants thousands of dollars a year. There's a good chance they can do the same for you. For full details on J-M's free Engineering Service and on J-M Insulating Materials, simply write Johns-Manville, 22 East 40th Street, New York City.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville

INDUSTRIAL INSULATIONS

For every temperature . . .
For every service condition

Reduce Your Fuel Costs in 1940

Photo by Courtesy of Eagle-Globe-Royal Indemnity Companies and Pennsylvania Sugar Company

When the engineers of the Eagle-Globe-Royal Indemnity Companies make a periodic inspection of electrical equipment which they insure, they take no chances on the insulation—they test it with a "Megger" Insulation Tester.

By this simple procedure and without risk of unnecessary breakdown, they penetrate unseen conditions caused by dirt, moisture and deterioration, and decide whether the insulation is in good or poor condition.

Hundreds of thousands of similar recorded tests made by leading Insurance Companies, as well as tests made independently by Operating Engineers, have shown that periodic insulation testing is an indispensable procedure for preventing unexpected electrical breakdown and unnecessary outages and repairs.

Why take chances? Whether you carry electrical insurance or not, you want to avoid electrical breakdown. "Megger" testing is the practical way to go about it.

"MEGGER"

TRADE MARK REGISTERED U.S PAT OFF.

Write for a copy of our Pocket Manual of "Megger" Practice, No. 1420-P.

JAMES G. BIDDLE CO.

1211-13 ARCH STREET PHILADELPHIA, PA.

Engineers' Books

(Continued from page 112)

tables and charts covering piston speed and rpm, horsepower per cylinder, belting design, cooling tower dimensions, piping capacity, fuel economy, and heat recovery.

This handbook makes up, to a large extent, for the past lack of published data on gas engine characteristics and application.

Stokers

FIELD SURVEY OF THE RELATION BETWEEN COMBUSTION SPACE AND SETTING HEIGHT TO SMOKE WHEN FIRING BITUMINOUS COAL WITH UNDERFEED STOKERS (1939). *By R A Sherman, R C Cross, and H N Ostborg. Published by the Stoker Manufacturers Assoc, 307 N Michigan Ave, Chicago, Ill. 33 pages, 8½x11 in., mimeographed, 19 illustrqtions, paper covers. Price $1.00.*

Presenting data from a factual survey of 102 installations and an experimental study of 22 installations in Columbus and Cincinnati, Ohio; St Louis, Mo.; and Chicago, Ill.; this report sums up field research by engineers of Battelle Memorial Institute for the Stoker Mfrs Assoc, the National Coal Assoc, the Institute of Boiler and Radiator Mfrs, the Steel Heating Boiler Institute, and the Smoke Prevention Assoc.

The report briefly discusses fundamentals of smokeless combustion and points out that (1) when stoker is "off," distribution of air and coal is non-uniform and smoke emission tends to be greater, (2) the way to prevent smoke emission from chimneys is to prevent its formation in the fuel bed, and, (3) type of coal, excess air carried, uniformity of coal distribution on stoker, type of load, and intelligence and ability of operator are of equal importance with rate of heat liberation or setting height in the elimination of smoke.

Diesel Fuels

IGNITION-QUALITY RATING OF DIESEL FUELS BY COMMERCIAL ENGINES (1939). *By Jasper S Chandler. Published by The Pennsylvania State College, State College, Pa. (Engineering Experiment Station Series, Bulletin No. 47) 82 pages, 6x9 in., illustrated, paper covers. Price $0.75.*

This bulletin describes tests to compare ignition-quality ratings of 7 fuels as measured on 9 commercial engines of various types and sizes and as measured on the Cooperative Fuel Research (CFR) engine. Results indicate that ignition ratings on commercial engines vary only slightly among themselves, but that they average 3 cetane points higher than the laboratory ratings on the CFR engine.

In addition to detailed data regarding the fuels and engines used and the results obtained, the bulletin includes a brief

Chapman

MOTOR UNITS

AND MOTOR DRIVEN FLOORSTANDS

Improved Chapman Motor Unit
Yoke Mounted on Chapman Gate Valve
Direct or Remote Push Button Control

For the Electrical Operation of Power Plant Valves

Positive, dependable operation is a primary requisite in the electrical operation of power plant valves. The increasing use of Chapman Motor Units in this field is the logical result of fine performance records in all fields. The unit is extremely rugged and simple. No effort has been spared to insure its dependability and durability. Elimination of all *jamming* possibility is one of the many features making this unit the outstanding choice for power plant service. Send for bulletin describing the Chapman Motor Unit.

Motor Operated
Floorstand

THE CHAPMAN VALVE

MANUFACTURING COMPANY

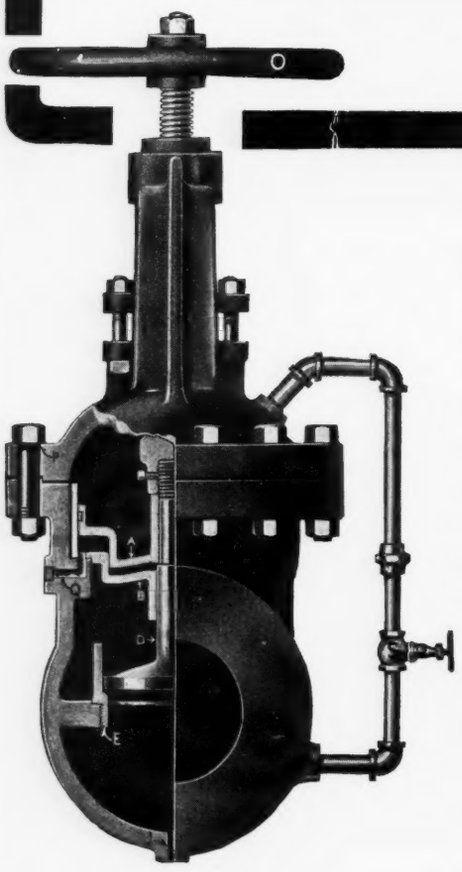
INDIAN ORCHARD, MASS.

★

Golden-Anderson

SPECIALTY

VALVES



THROTTLE AND EMERGENCY STOP

Automatically shuts down any over-speeding engine or turbine. Works *instantly*. Operates mechanically, electrically or by hand. Can be tripped from remote points by the push of a button. No engine or turbine can go faster than the maximum speed set for safe operation, when equipped with this valve. Hundreds in use, on all types of steam engines and turbines. Made in angle and globe patterns, in sizes from 2½" to 16", any pressure.

Ask for details and catalog of entire G-A line.

also

Triple Acting Non-Return . . . Pressure Reducing . . . Altitude Control . . . Float Control . . . Check Valves, etc.

Golden-Anderson Valve Specialty Co.

Fulton Bldg. • • • Pittsburgh, Pa.

discussion of ignition quality and methods of measurement, as well as descriptions of the instruments and methods used in the Penn State investigations.

Patents

PATENT FUNDAMENTALS (1939). *By Adelbert Schapp, of Schapp and Cole, Patent Attorneys, San Francisco. Published by The Industrial Press, 148 Lafayette Street, New York, N. Y. 176 pages, 5½x8½ in., cloth binding. Price $2.00.*

Engineers and executives who must deal with inventions or who feel the inventing urge will find this book a straightforward and concise statement of patent "whys and wherefores". Following a careful analysis of what is patentable and what isn't, illustrated with many practical case studies, the author follows step-by-step the procedure involved in protecting an idea from its conception to and including its commercial application. Pitfalls which may trap the unwary inventor are explained, and important court decisions are clearly stated and fully analyzed. The text covers design as well as utility patents and includes chapters on trademark and copyright protection.

Inventors will always need the services of patent attorneys, experts in the field, but study of this book should make the inventor, engineer, or executive a better judge of patent claims and better fitted to cooperate intelligently with the patent attorney in the preparation and prosecution of patent applications.

Pump Materials

MATERIAL SPECIFICATIONS FOR PUMPING EQUIPMENT (1939). *Published by Hydraulic Institute, 90 West St, New York, N. Y. 16 pages, 8½x11 in., paper binding, Price 25 cents.*

These specifications were prepared by the Committee on Material Specifications of the Hydraulic Institute and cover cast materials generally used in the manufacture of pumping equipment for the petroleum industry. A specification covering bolt and nut materials for similar service has also been prepared.

With many unrelated specifications for similar types of material available, the average engineer is at a loss when trying to select the most favorable one for a pump application. As a result, pump manufacturers are required to produce so many variations of the same type of material that the cost of manufacture and delivery time are considerably increased. Adherence to the new specifications by pump purchasers will do much to eliminate these evils.

Electrical Wiring

PRACTICAL ELECTRICAL WIRING (1939). *By H P Richter, Member, International Association of Electrical Inspectors. Published by McGraw-Hill Book Co, Inc. 330 W 42nd St, New York, N. Y. 503*

PIPING BY
MIDWEST

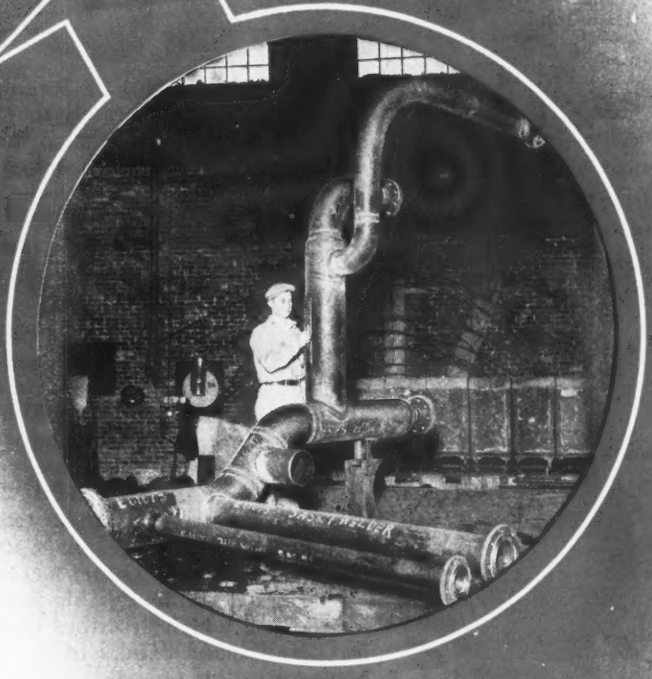
Precision Pre-Fabrication SAVES YOU MONEY

Everybody knows that precision pays . . . that parts which fit immediately save so much money in assembly that any other kind are prohibitive in cost.

Precision in piping also pays. Piping by Midwest is pre-fabricated into a series of sub-assemblies which fit together precisely . . . which make erection a matter of relatively few field joints. Savings of time and money are obvious. In addition, the resulting piping job is superior.

Midwest Piping is pre-fabricated in modern plants, by skilled piping specialists, under controlled manufacturing conditions. Proper machinery is available to assure quality work; welders and other workmen are well trained. The work is directed by men of long experience in every type of piping.

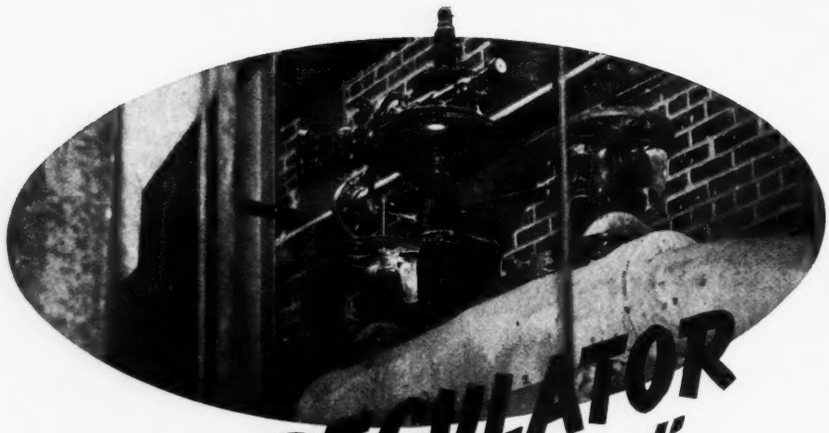
Call on Midwest for Piping—no matter how small or how large the job.



MIDWEST PIPING & SUPPLY CO., INC.

Main Office: 1450 So. Second St., St. Louis, Mo.

Plants: St. Louis, Passaic (N. J.) and Los Angeles • Sales Offices: Chicago—946 Marquette Bldg. • Houston—2306 Shakespeare Road • Los Angeles—520 Anderson St. • San Francisco—426 Call Bldg. • New York—(Eastern Division) 30 Church St. • Tulsa—533 Mayo Bldg.



THIS REGULATOR "Draws Circles" TO SAVE YOU MONEY

The Masoneilan No. 27 Regulator controls pressure so accurately that it "draws circles" on the charts of recording instruments—and continues to do so day after day—year after year—without continual adjustment for load changes; without shift from control setting between full open and closed; without control time lag; as witness the chart above.

This accuracy, plus ease of placing in operation, plus rugged, fully inclosed construction adds up to a real saving in operating and maintenance expense; a saving which quickly repays the initial cost of the regulator and goes on to increase your profit margin. . . Use Masoneilan No. 27 Regulators on primary and secondary steam lines, desuperheating service, make-up service, pump regulation and other services requiring accurate, stable, reliable control. Ask for Catalog which describes these regulators—and many others in the complete Masoneilan line.

MASON-NEILAN REGULATOR CO.
1186 ADAMS ST., BOSTON, MASS.

MASONEILAN
REG. U.S. PAT. OFF.

NEW YORK BUFFALO PHILADELPHIA PITTSBURGH TULSA
TOLEDO CHICAGO ST. LOUIS HOUSTON LOS ANGELES
MASON REGULATOR CO. OF CANADA, LTD., MONTREAL, CANADA

pages, 5½x8 in.; 457 illustrations; 36 tables; cloth binding. Price $3.00.

Practical methods of electrical wiring are explained in plain easy language in this book for the man who does the work. All methods shown are in accordance with the National Electrical Code, but no attempt has been made to include a detailed explanation of all subjects covered by the Code. The scope of the work has been limited to wiring of structures where the circuits operate at less than 600 volts and is divided into three parts:

Part 1 deals with the National Electrical Code, kinds of devices used in electrical wiring, types and size of wires, wire connections and joints, different methods of wiring and presents the fundamentals of electrical work, basic principles, and the theory behind general practice.

Part 2 covers wiring of residential and farm buildings, tells how to plan a wiring installation, how to install service entrances, ground wires, outlets, and other devices, and how to wire old buildings, isolated lighting plants and apartment houses. Part 3 gives instruction on how to wire factories, stores, schools and similar structures including wiring for motors. An appendix includes the National-Electrical Code tables. The treatment is practical and can be easily understood by the ordinary wireman as well as by the more advanced student of electrical circuits.

Wrought Iron

WROUGHT IRON—ITS MANUFACTURE, CHARACTERISTICS AND APPLICATIONS (Second edition, 1939). *By James Aston and Edward B Story of A M Byers Co. Published by A M Byers Co, Pittsburgh, Pa. 97 pages, 6x9 in., tables and illustrations. Cloth binding. Price $1.00.*

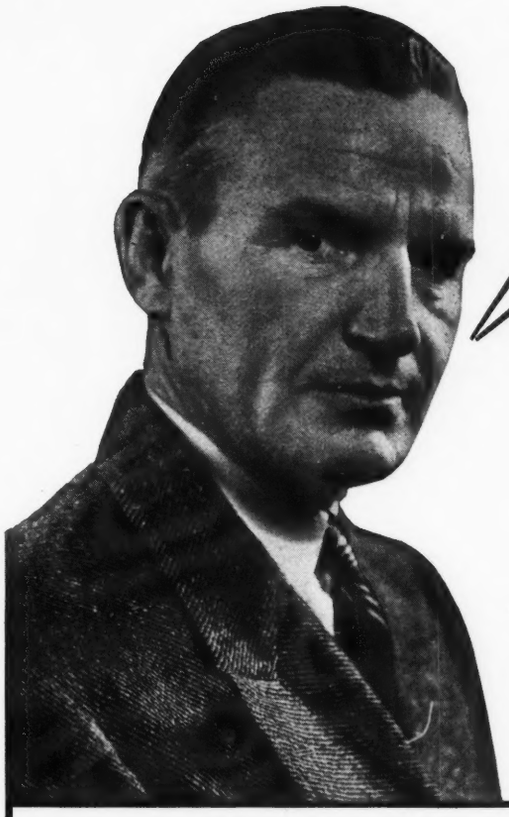
While this book is normally sold for $1.00, as indicated, we understand that it will be supplied, without charge, to any reader of POWER who may request a copy on his business stationery.

Starting with an interesting historical discussion of wrought iron, the book also gives much practical information, including analyses, quality standards, specifications and durability testing, suggestions for forging and bending of wrought iron, glossary of terms relating to wrought-iron manufacture and products.

Industrial Health

INDUSTRIAL HEALTH, ASSET OR LIABILITY (1939). *By Dr C O Sappington. Published by Industrial Commentaries, 160 N La Salle St, Chicago, Ill. 224 pages, 5½x8½ in.; 24 model examination and industrial health survey forms; cloth binding. Price, $3.75.*

Losses resulting from sickness in industry are almost unbelievable. The author emphasizes this statement by citing reliable estimates that show no less than 10 billion dollars are lost annually on account of sickness among industrial employees. Each year the 40-million workers in the



"NEVER BELIEVED SUCH COMBUSTION RESULTS WERE POSSIBLE"

Says **MAJOR OIL REFINERY, ABOUT THE FANMIX GAS BURNER**

Another COPPUS BLUE RIBBON *Product*

The steam engineer of one of the country's largest petroleum refineries, having operated FANMIX burners over a six month period writes: "Since the installation of FANMIX Burners the average load on the still has been increased 25%. The flue gas temperature dropped from 620° to 530° F. and the CO_2 increased from 9.4% to 11.4%.

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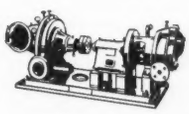
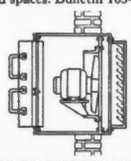
Designed for your Industry
Engineered for You

COPPUS TANK AND TANK CAR VENTILATORS. For quick ventilation of Tank Cars, Tanks, etc. Supplies fresh cooling air to men working in confined spaces. Bulletin 163-1.



COPPUS STEAM TURBINES. For small H.P. jobs—six sizes (and prices) from 150 H.P. down to fractional. Steam — Gas—or Compressed Air driven. Bulletin 135-9.



COPPUS VENTILATOR FILTERS. A combination Ventilator and Air Filter for industrial applications. Bulletin F-370-1.

HEAT KILLERS. Keep production up by keeping men cool. Also for cooling of motors, generators, etc Bulletin 160-4.

NEW OPERATING METHOD

Ensures Perfect Gas . . . Air Ratio

Gas escaping through orifices in the revolving arms, drives the fan and draws in the correct proportion of air. The result is instantaneous, complete combustion. Not only does this give you higher ratings, but you also get eleven other unique benefits from Coppus-Dennis Fanmix Burners.

WRITE FOR FREE FANMIX BULLETIN 410-2

Like all other Coppus products, the Fanmix Gas Burner has a Blue Ribbon. This is your assurance of precision workmanship and careful inspection. Note other Blue Ribbon products described at left.

Coppus Engineering Corporation, 350 Park Avenue, Worcester, Massachusetts. Sales Offices in THOMAS' REGISTER: other "Blue Ribbon" products in SWEET'S.

COPPUS

ADVERTISING PAGES REMOVED

Model 135 Air-driven Motor with self-feeding cage-type head, and air valve for one-man operation.

ROTO

Rapid-action Tube Cleaners Reduce Fuel Losses at Less Cost

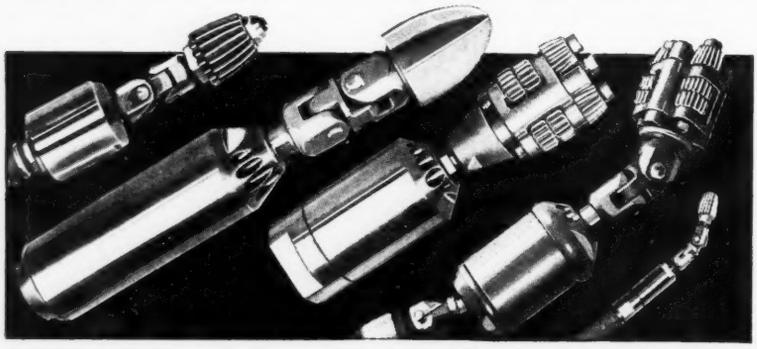
The Roto Rapid-action Tube Cleaner has set new records for speed, economy and thoroughness in tube cleaning. Unbelievable power is developed through the new motor design. A rapid-action air valve, directly behind the motor, enables one man to operate the cleaner by himself, eliminating the usual delays due to signalling between tubes and saving the cost of a helper.

For extremely hard, thin scale a rugged self-feeding cage-type head is available.

The time and labor-saving features of the Roto Rapid-action Tube Cleaner will quickly return your investment, and pay you handsome dividends in fuel savings.

Write or wire for details.

THE ROTO COMPANY
145 Sussex Ave., Newark, N. J.



United States contribute the staggering total, 280-million working days, because of ill health.

This is not the wail of an idealist or an alarmist, but a presentation of facts by a practical man of very wide experience in industrial-health problems. After giving us a shock, he proceeds to show how industry can make good health of its employees one of the great assets of modern business life.

Complete information, based upon years of experience and contact with industrial-health problems, is given on how to establish practical health programs in large and in small industries. Written in an easily read style, in terms which the layman as well as the professional can understand, this book merits the attention of everyone interested in health problems.

Steam Engines

A HISTORY OF THE GROWTH OF THE STEAM ENGINE. *By Robert H Thurston. Republished, 1939, by Cornell University Press, Ithaca, N. Y. 555 pages, 5x8 in., cloth binding. 182 illustrations. Price $3.*

Robert Thurston, one of America's most distinguished professors of mechanical engineering, has been dead for many years. He was director of the Sibley College of Mechanical Engineering, Cornell, from 1885 to 1903.

"History of the Growth of the Steam Engine" appeared first in 1878 and passed through six editions, the last in 1907. Even today it is considered a classic and, for historical purposes, better than many more recent accounts. This new edition, therefore, celebrates the 100th anniversary of Thurston's birth, Oct. 25, 1839.

A supplementary chapter, written by William M Barnard, director of the Sibley School of Mechanical Engineering, brings steam history up to date. There are histories and histories. After long study of past wars, dynasties and political intrigues, nothing is more refreshing than the study of *mechanical* history.

New Equipment

(*Continued from page* 128)

flame. Mixture said not to have any harmful acids or petroleum derivatives, and manufacturer claims that it will not alter flash point of oil.

Combustion Service Co, 1451 Broadway, New York, N. Y.

Magnetic Switches

NEW SIZE and type magnetic switch available for use with single-phase motors up to 1 hp, 110 volts, and 1½ hp, 220 volts, or polyphase motors up to 1½ hp, 110 volts, and 2 hp, 220-600 volts. Magnet of switch is of the E-type with three sealing surfaces to decrease the hammer blow in closing and to increase the life of the

(*Continued on page 142*)

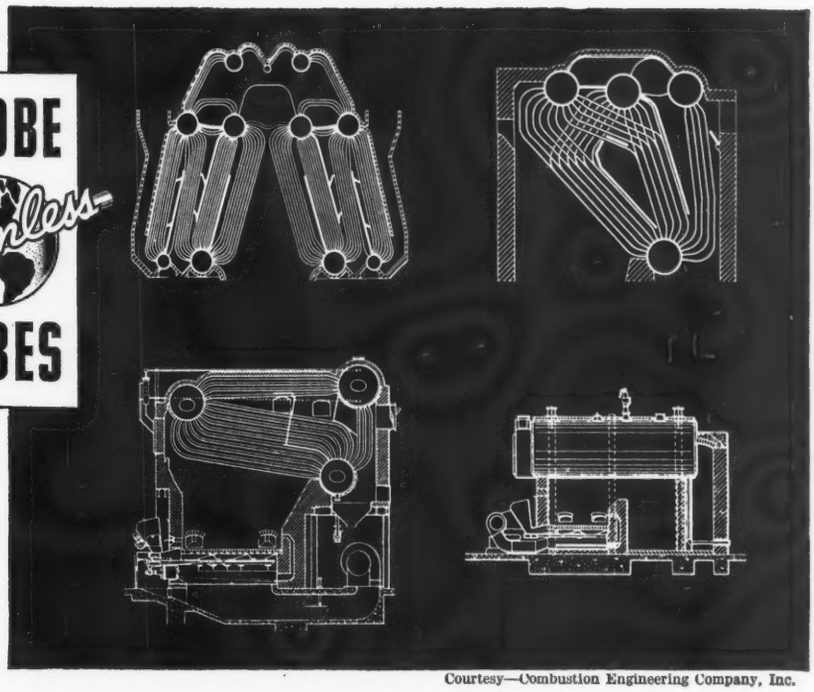
Watch for these "handbook" articles

1. **Alternating-current motors—April.**
2. **Diesel data—200 plants—June.**
3. **Engineering data on 400 modern steam and hydroelectric plants—September.**
4. **Principles and practice of combustion—December.**

It Pays You to Read POWER Regularly

GLOBE Seamless TUBES

Modern BOILERS . . . REQUIRE



Courtesy—Combustion Engineering Company, Inc.

MODERN "SEAMLESS FOR SAFETY" TUBES

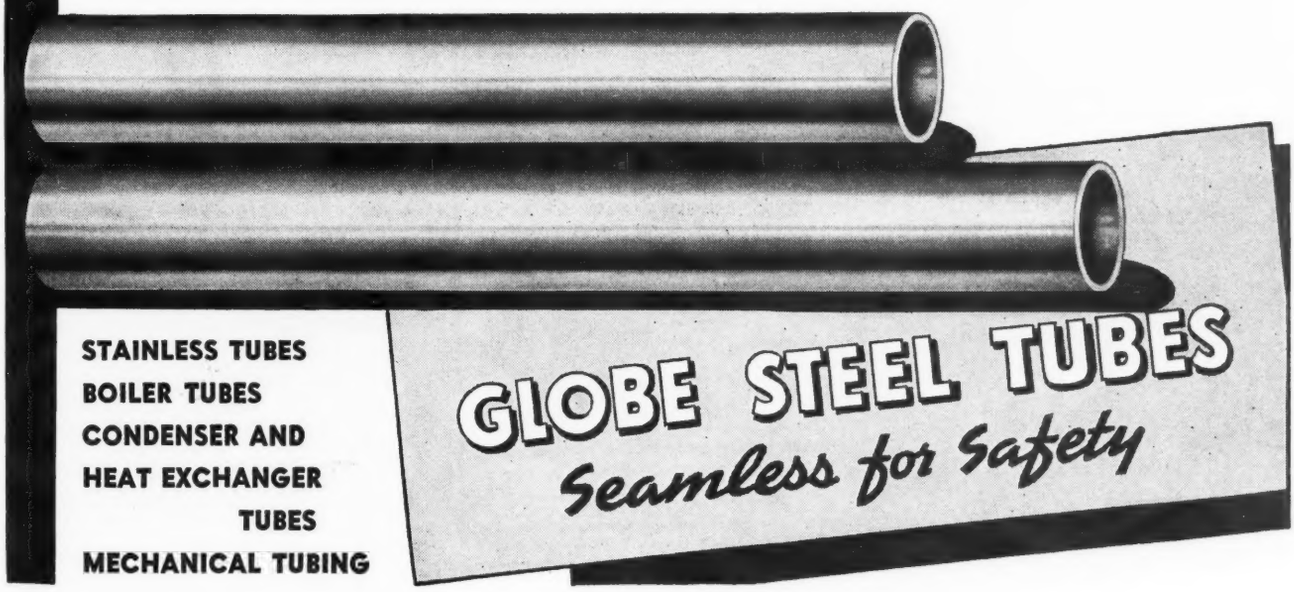
NEW standards of performance and operation — increased safety requirements demand the plus factors . . . the extra value provided by Globe Seamless Steel Tubes.

In boiler tubes even a small added margin of strength can spell the difference between safety and disastrous loss. Note these five outstanding Globe "Seamless for Safety" features:

1. No seams or welds. Globe Seamless Steel Tubes are free of weak points, as along the line of a weld, which might give a starting place for costly failure.
2. Structurally uniform and sound from end to end; each tube pierced from a solid billet of steel, resulting in complete homogeneity of wall structure.
3. Only first-quality killed open hearth and electric furnace steels can survive the Globe piercing operation—a positive guarantee of the soundness of the steels used in producing Globe Tubes.
4. The smooth, solid, unbroken surfaces of Globe Tubes afford the utmost resistance to destructive corrosion.
5. Long service records in many of the nation's noteworthy power plants — their use by leading railroads, industrial and marine boiler builders—attest the greater value, safety, and savings of Globe Seamless Steel Tubes.

Globe engineers are always available to assist in selecting a tube with the exact characteristics for your specific needs. Check with a Globe engineer before you specify boiler tubing.

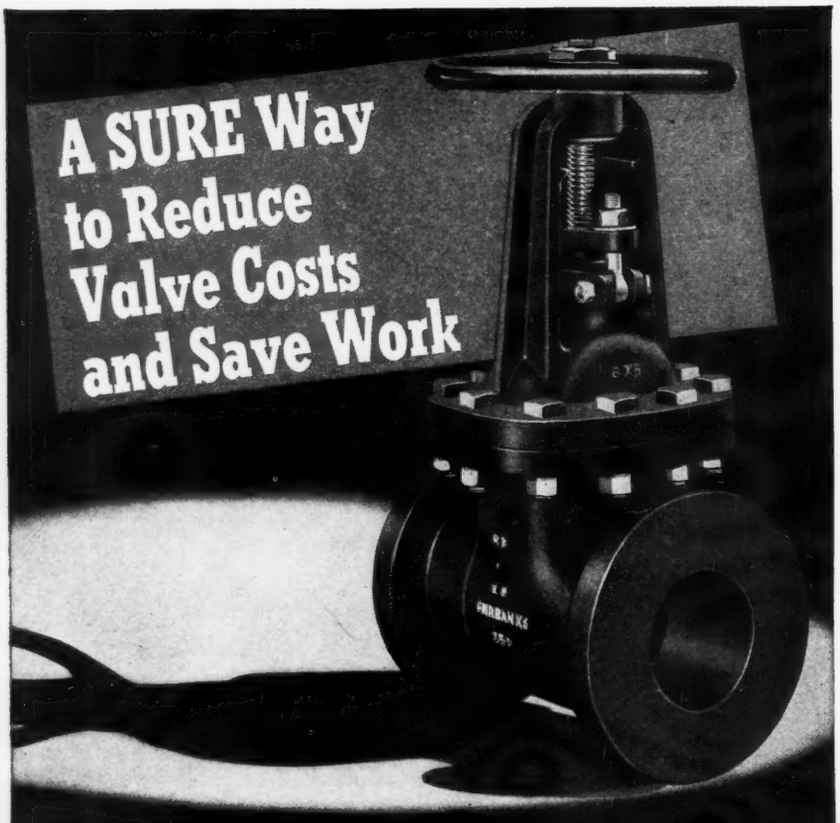
GLOBE STEEL TUBES CO. • 4050 W. Burnham St., *Milwaukee, Wis.*



STAINLESS TUBES
BOILER TUBES
CONDENSER AND
HEAT EXCHANGER
TUBES
MECHANICAL TUBING

GLOBE STEEL TUBES
Seamless for Safety

A SURE Way to Reduce Valve Costs and Save Work



People are apt to forget that the true cost of valves is their original cost *plus* the cost of maintenance.

If you are using valves that are hard to repair when they leak and which have to be removed from the line to make repairs, switch to Fairbanks *Renewable* Valves. Then worn seat rings or wedges can be renewed by one man in a *few minutes*, without removing the valve from the pipe line, at about 5% of the price of a new valve. Fairbanks Renewable Valves do away with lengthy, costly shut-downs.

A small inexpensive stock of Seat Rings and Wedges will repair a large number of Fairbanks Valves, as the standard, heavy and extra-heavy parts are interchangeable. That eliminates the need of maintaining a large stock of expensive valves.

Fairbanks Valves withstand the most brutal punishment because they are made of special semi-steel alloy which has a tensile strength 5,000 to 10,000 lbs. (or 66⅔%) greater than ordinary cast iron.

Measured by actual cost over years of service, Fairbanks Renewable Valves yield the greatest return on your investment.

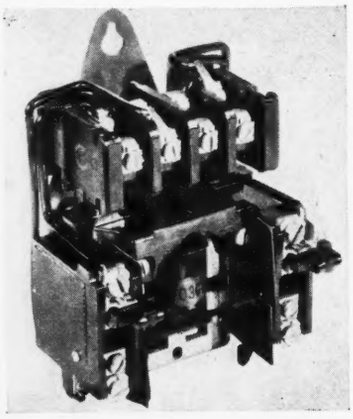
Write for catalog No. 21 and name of our nearest distributor.

THE FAIRBANKS CO.
399 Lafayette St., New York, N.Y.
Boston • Pittsburgh
Distributors in Principal Cities
Factories: Binghamton, N. Y. • Rome, Ga.

To put in a new ring, simply place it in the valve body so the lugs on ring fit into recesses in valve. A short turn locks it in place.

Fairbanks Renewable Iron Valves

magnet. Contacts are double-break, made of silver, easily removable for inspection. Isothermic overloads are provided with a positioning spring which permits making



relay either hand or automatic reset. Overload relay is completely enclosed; and heaters providing for different motor ratings are mounted in the relay from front of switch.

General Electric Co, Schenectady, N. Y.

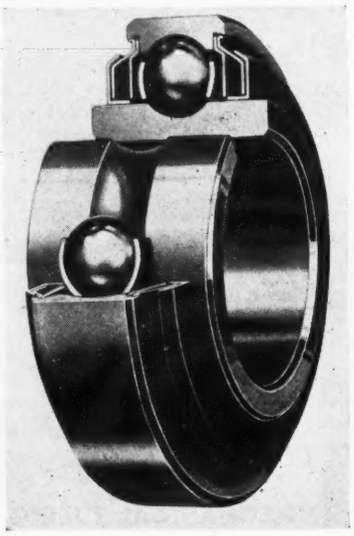
Pressure Regulator

TYPE P212A electric static-pressure regulator is designed for use with motorized damper, or similar device, to control static pressure in discharge duct of fan system, to control the overfire draft in a combustion chamber, or similar applications where definite static pressure conditions are to be maintained.

Minneapolis - Honeywell Regulator Co, 2247 Fourth Ave, South, Minneapolis, Minn.

Bearing Seal

"MECHANI-SEAL" design is integral part of bearing itself, and requires only housing of simple design with minimum of machining. Two steel plate shields, widely separated to form a trap, serve as the innermost members, both attached to the outer bearing ring. Another steel plate,



Lubricate your plant with Lubriplate —the New Principle Lubricant!

Are your lubricant bills running too high? Are replacements due to faulty lubrication excessive? Are you worried about noisy gears, hot running bearings or oil-dripping chains?

Then Lubriplate is your answer. Try Lubriplate on the *toughest* lubricating job in the plant. See for yourself how this *new principle* lubricant stops noise—ends dripping—cools running temperatures—slashes lubricant consumption—reduces labor charges to a minimum.

7 QUICK FACTS

1. *Lubriplate* produces a wear-resisting bearing surface.
2. *Lubriplate* resists rust corrosion and pitting.
3. *Lubriplate* reduces friction, thus lowering maintenance costs and power costs.
4. *Lubriplate* is white and clean.
5. *Lubriplate* outlasts ordinary lubricants many times.
6. *Lubriplate* is economical—a little goes a long ways.
7. *Lubriplate* is available in fluid and grease types for every need.

1 SAVE WORK

A large aluminum company* was forced to lubricate coilers, shears and presses from 2 to 3 times each shift. With Lubriplate, a *single lubrication* per shift was all that was needed. In addition, 1 pound of Lubriplate goes as far as 3 pounds of the former lubricant.

2 SAVE WORRY

A leading food packer* was faced with a mean lubricating problem. Oil was dripping badly from a single long conveyor which wove all about the shipping floor. The conveyor squeaked constantly. The day Lubriplate was introduced, squeaks and dripping stopped—*completely*. What's more, the Superintendent reports that "Lubriplate lasts a surprisingly long time. Now we are using Lubriplate on many applications."

3 SAVE MONEY

Prior to using Lubriplate, a leading vulcanized fibre company* found that *one* gear consumed 36 gallons of oil, required 4 gear replacements and $6 replacement labor over a six months' period—for a total cost of $79.82. During the next 6 months Lubriplate was used at a total cost of $2.50. No replacements. No labor charges.

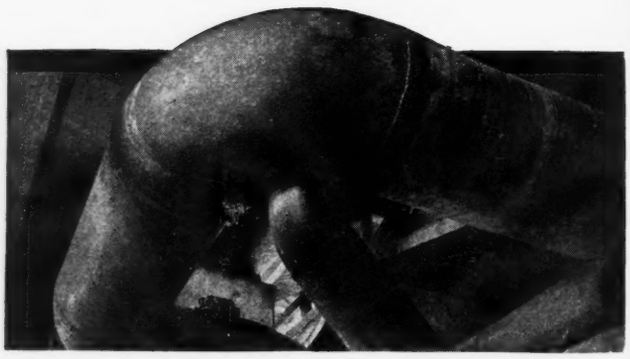
*NAMES ON REQUEST

TRY LUBRIPLATE TODAY

Lubriplate Division of
FISKE BROTHERS REFINING CO.
NEWARK, NEW JERSEY • TOLEDO, OHIO
Dealers from Coast to Coast

LUBRIPLATE

THE WHITE LUBRICANT THAT MINIMIZES WEAR



Of course

—the fittings with the MOST advantages are the fittings that can be used to BEST advantage.

WeldELLS have these eight features that are combined in no other fittings.

1 SEAMLESS
2 UNIFORMLY FULL PIPE THICKNESS
3 SELECTIVE, UNIFORM REINFORCEMENT
4 TANGENTS
5 MACHINE TOOL BEVELLED
6 ENDS MARKED IN QUARTERS
7 COMPLETE IDENTIFYING MARKS ON EVERY FITTING
8 A FULL LINE

TAYLOR FORGE & PIPE WORKS
General Offices and Works: P. O. Box 485, Chicago
New York Office: 50 Church St.

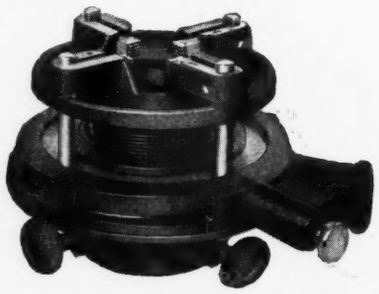
TAYLOR FORGE
WeldELLS
Seamless Pipe Fittings for Welding

pressed on the bearing inner ring, acts as a slinger when the inner ring is rotating. Definite though extremely close clearances exist between individual members so that nothing is added to bearing friction. Outer members are also given corrosion and rust-proof treatment.

Fafnir Bearing Co, 77 Booth St, New Britain, Conn.

Ratchet Threader

ADJUSTABLE threader uses separate bushings for each size pipe to assure centering of pipe. Uses receding die principle, with a separate set of dies for each size of

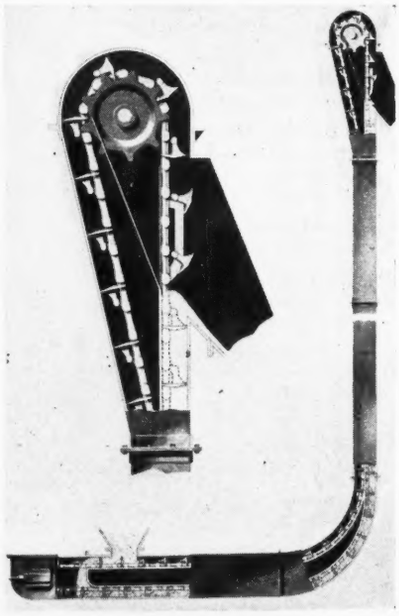


pipe. Has tubular handle 24 in. long, and has simple adjustment for over and under size pipe, as well as standard threads.

Toledo Pipe Threading Machine Co, 1431 Summit St, Toledo, Ohio.

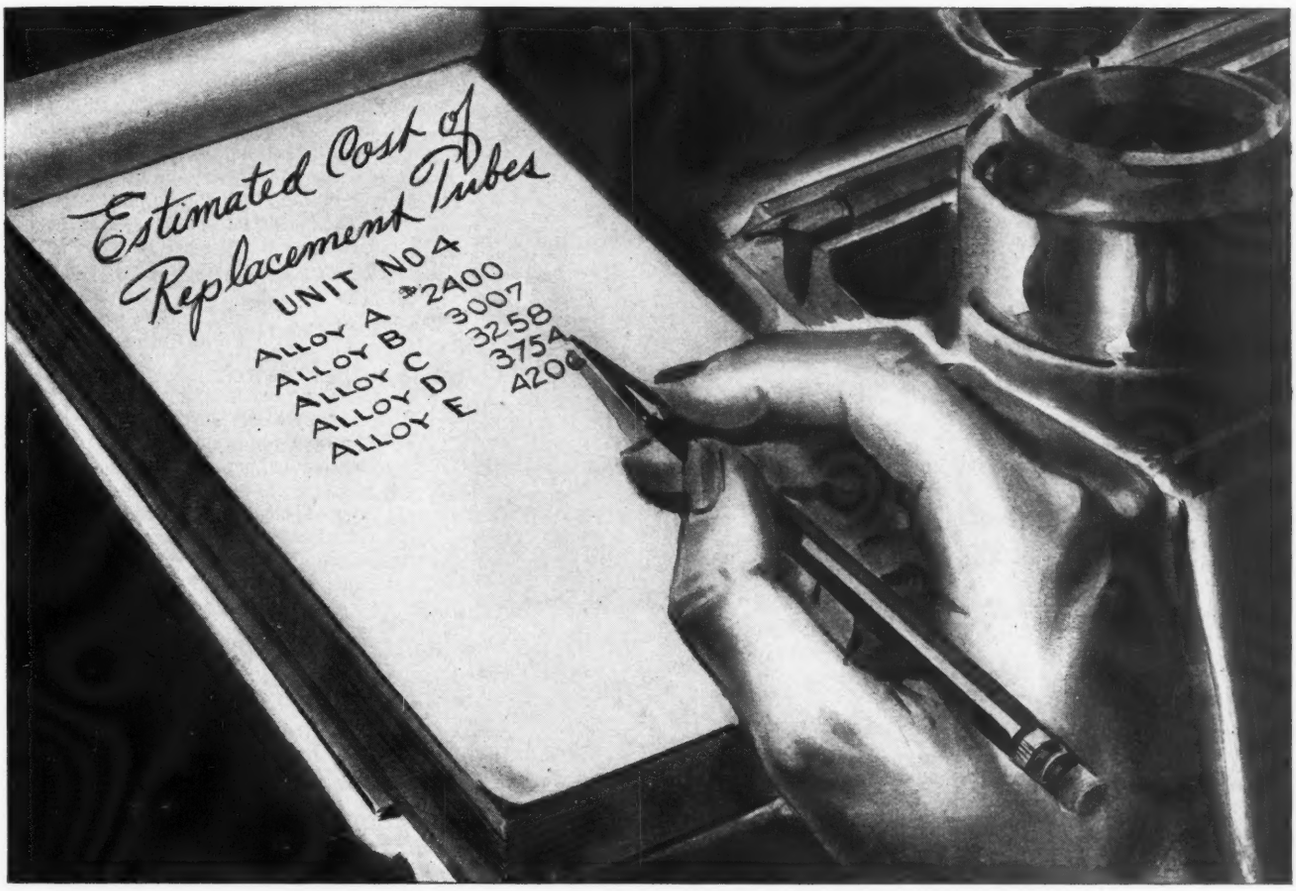
Elevator-Conveyor

"MASS-FLO" elevator-conveyor provides unique method of handling granular materials such as coal, sawdust, chemicals, etc. Simple in design and construction, unit



consists of a steel casing through which solid pivoted flights spaced at intervals on single strand of chain, moves material horizontally or vertically in solid mass or

WHICH CONDENSER TUBE ALLOY WILL COST THE LEAST?



. . . LET A BRIDGEPORT ENGINEER HELP YOU DECIDE

You can easily find the *first* cost of various alloys for your condenser or heat exchanger tubes — but the *real* cost depends on the life of the tubes in your application. Perhaps a low-priced alloy will give you entirely satisfactory service. Or, if your operating conditions are severe, one of the newer, more highly resistant alloys may pay for itself out of savings in maintenance costs.

There is no rule of thumb for predicting tube life. Temperature, velocity, gas content, and a host of other factors all play a part. Actual operating experience is the only true test of the effect of these factors on a specific tube alloy.

That is why a Bridgeport Condenser Engineer can help you in selecting a tube alloy. From his first-hand studies of condensers and heat exchangers in every type of plant, he has amassed a wealth of information on the performance of numerous alloys under widely varying service conditions. He is in a position to apply this experience to the conditions in your plant—to assist you in striking the most economical balance between the first cost of an alloy and its life in service. Let his experience supplement yours—consult with him when you are planning a new or retubing job on condensers or heat exchangers. His advice will aid you in obtaining low over-all tube cost.

"Bridgeport" BRASS CO.

BRIDGEPORT BRASS

BRIDGEPORT BRASS COMPANY • BRIDGEPORT, CONN. • ESTABLISHED 1865

WRITE FOR YOUR COPY

BRIDGEPORT BRASS COMPANY,
Condenser Tube Engineering Dept. C,
Bridgeport, Conn.

☐ I'd like to have a copy of the new revised "Condenser Tube Manual."

☐ I'd like to talk to one of your condenser engineers about my problem.

NAME .....

COMPANY ..... TITLE .....

ADDRESS .....

CITY ..... STATE .....

Easy to install

-AND WHY!

W-S FORGED STEEL FITTINGS simplify the installation job. Using the Socket-End welding type, you just slip the fitting over the pipe-end and make a clean outside-the-pipe weld. No tack welding . . . no special fixtures required. ● Wide, heavy bands on the Screw-End type provide the ample wrench surface for quick, easy make-up. Long and accurate threads insure tight, square joints. ● Both types are designed for precision self-alignment. For handling steam, water, oil, gas or ammonia . . . under all conditions of high pressure and temperature!

THE WATSON-STILLMAN COMPANY, ROSELLE, NEW JERSEY

WATSON-STILLMAN
Forged Steel Fittings

with partial load. At discharge point, see illustration, flights are discharged by tripper, and unit can be emptied after feed stops.

Jeffrey Mfg Co, 932-99 N 4th St, Columbus, Ohio.

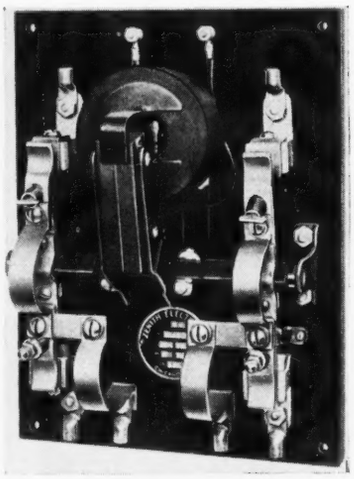
Soldering Paste

"MELTOMATIC" paste solder is brushed on metal only where needed, can be heated with gas or other flame, electricity, hot oil, or in the furnace. Will melt at a temperature slightly higher than 400 F. Said to save time and money, because no material is wasted, can be applied without usual equipment for soldering, and makes stronger bond.

Wayne Chemical Products Co, Detroit, Mich.

Transfer Switch

AUTOMATIC transfer switch, spring gravity drop-out type, is for automatically connecting lighting or power load to an emergency source in case of failure. Contacts are copper-to-copper and operate with rolling and wiping action. Compression springs provide required contact pressure and permit quick opening. Available for standards



voltages 110 to 120 or 208 to 240 volts, 25, 50 or 60 cycles, and 115 or 230 volts dc. Constructed for transfer for ac to ac, ac to dc, dc to dc, or dc to ac, with a current capacity range from 30 to 300 amp. Switch will transfer when voltage of circuit drops to 70% or less and will restore the load to normal source when voltage reaches 90%.

Zenith Electric Co, 845 South Wabash Ave, Chicago, Ill.

Flanged Valves

VALVE is similar to Type D solenoid valve, except that this model operates on 250 lb pressure instead of 150, has newly designed solenoid with glass insulation, which will withstand higher temperatures, and has modernistic coil shield, which is said to dissipate heat.

Hoppe Engrg Co, Inc, Indianapolis, Ind.

MORE BOILER SAFETY AND ECONOMY FOR YOU

Technical School Engineers Point Way by Installing Reliance EYE-HYE Remote Reading Water Gage

THE MOST important development in recent years toward making water level reading a frequent, almost automatic check to insure safe operation of your boilers is the EYE-HYE. It brings a clear, accurate reading down to the operating floor—*down to eye level*—conveniently placed for constant observation.

Since its introduction, EYE-HYE has gained recognition steadily by power users everywhere, by consulting engineers, and by the engineers of many schools and colleges where the safe and efficient operation of equipment is demonstrated often to students.

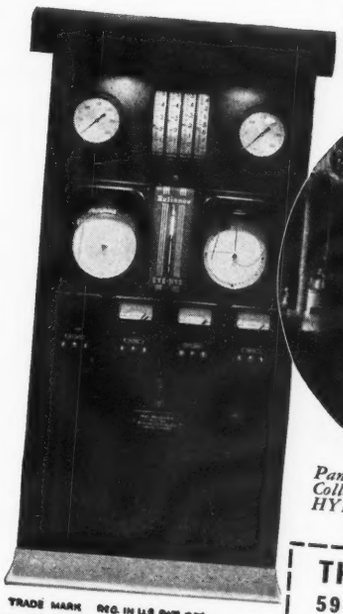
EYE-HYE'S green indicating fluid is brilliantly illuminated, making the reading visible from a greater distance and quicker than most instruments. Its simple operation, based on the well-known U-tube principle, and rugged construction assure constant error-proof water level check without troublesome adjustments and expensive repairs.

Installation is easy. Two small tubes run up the wall, around pipes and girders, connect EYE-HYE to the boiler drum—no costly piping to do.

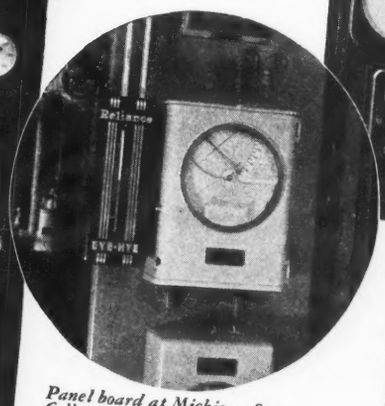
The hundreds of engineers who have installed EYE-HYE enjoy new freedom from water level worries—are proud of this modern device among their controls. Add this efficient water level SIGHT check to your boiler room for safety and economy. Write today for Bulletin 382.

Some of the Schools and Colleges where EYE-HYE Guards Boiler Water Levels

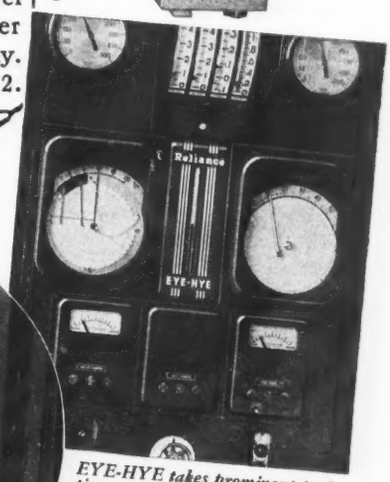
Purdue University
Michigan State College
Case School of Applied Science
Virginia Polytechnic Institute
West Point Military Academy
Culver Military Academy
Western States Teachers College
Louisiana Polytechnic Institute
Louisiana State Normal College
University of Washington
Illinois State Teachers College



Model E-10 EYE-HYE at Case School of Applied Science, Cleveland.



Panel board at Michigan State College, Lansing with EYE-HYE centrally located.



EYE-HYE takes prominent position on panel at Virginia Polytechic Institute.

Reliance

TRADE MARK REG. IN U.S. PAT. OFF.

Boiler Safety Devices since 1884

THE RELIANCE GAUGE COLUMN COMPANY
5902 CARNEGIE AVENUE CLEVELAND, OHIO

Please send your free Bulletin 382 describing the EYE-HYE.

Name_____

Company_____

Address_____

IN DETROIT... *it's Solder and Cotton!*

IN JACKSONVILLE... *Tobacco Dust!*

In your plant it may be lead dust, silica sand, papers or sawdust —or maybe just plain dirt that slows up production, injures the product, produces rejects and lost output. Probably even now it is costing you more to "clean" your plant than it would to really clean it with a Spencer Vacuum Cleaning System.

A survey of 440 plants using Spencer Vacuum on areas varying from a single department to a million square feet shows that it is universally used for walls, ceilings and pipes, as well as floors and that the cleaning is frequently done during working hours. In addition it is used to clean machinery, raw material, packages, finished goods, and to reclaim valuable scrap materials.

You can write a Spencer System off with its savings in two or three years. It is built to last a lifetime. Many of them have been in service for a quarter century.

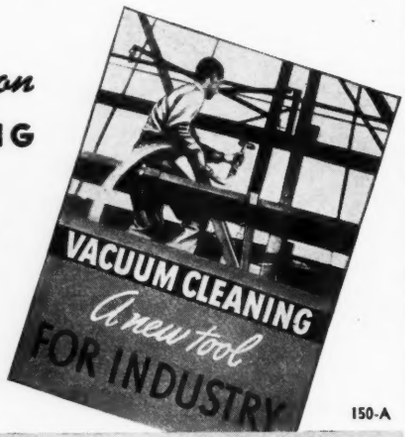
Write for this New Book on

INDUSTRIAL CLEANING

See how others clean large areas at low cost and save in production and maintenance because Spencer does the jobs that cannot be done by other methods.

The complete line of Spencer Portable and Central Systems from 1/3 H.P. up—and the Spencer Industrial Vacuum tools are described in this book. Yours on request.

ASK FOR BULLETIN 120-P



150-A

SPENCER HARTFORD

CENTRAL AND PORTABLE VACUUM CLEANING SYSTEMS

THE SPENCER TURBINE COMPANY, HARTFORD, CONN.

Power Lines

(Continued from page 118)

Omaha, Neb., entire state of Nebraska and western counties of Iowa; Geo A McLaughlin, 741 Stanton Ave, Springfield, Ohio, counties making up that trading area; W B Simons, 2434 Briarwood Road, Charlotte, N.C., covering North Carolina, except extreme western counties; Empire Gas & Equipment Co, Denver, Colo., entire state of Colorado and southeastern Wyoming.

STONE & WEBSTER, INC, is celebrating its 50th Anniversary this year. The corporation was founded in 1889 by Charles A Stone and Edwin S Webster, two consulting electrical engineers. Both Stone and Webster are still with the business, serving as chairman and vice-chairman, respectively. The initial construction job was the installation of one of the country's earliest commercial hydro-electric plants for the S D Warren Co at Saccarappa, Maine. Some of the most recent jobs have been for the Victor Chemical Works, Bridegport Brass Co, Johns Manville Co, and others.

NASH-KELVINATOR CORP announces election of Howard A Lewis as vice-president and G V Egan as treasurer. Lewis has held the position of treasurer of the corporation for the past ten years, and Egan has held the position of assistant treasurer for the past 12 years.

WESTINGHOUSE ELECTRIC & MFG CO, East Pittsburgh, Pa., announces election of two new directors. These are George A Blackmore, president, Westinghouse Air Brake Co, and Arthur W Page, vice president and director of the American Telephone & Telegraph Co of New York. Mr Blackmore is also president of the Union Switch and Signal Co of Swissvale, Pa., while Mr Page holds the position also of a director in the Continental Oil Company.

O'BRIEN MACHINERY CO, Philadelphia, Pa., is celebrating its 25th anniversary as manufacturer of power equipment. Company was established in 1915 by Frank L and Clarence J O'Brien, the present members of the firm. The company also specializes in rebuilding all types of equipment.

W H MARK HANNA, director, State Efficiency Engineering Div, Lansing, Mich., announces that the entire file of the State Administrative Board is being revised, and all new catalogs, bulletins, etc pertaining to heat, light and power equipment, machinery and supplies etc, are now being added.

CARBORUNDUM CO announces transfer of H W Collinson, for many years district sales manager in Cleveland industrial territory, to the position of district sales manager at Chicago, Ill. Mr. Collinson takes over the post formerly held by F E Gridley, who has been granted a leave of absence. To succeed Mr Collinson at

"I got some good ideas out of these bulletins"

Perhaps You Could, too—

WHETHER your problem is keeping a plant in dependable running condition, reconditioning an old one, or building a new one, nothing pays better dividends than checking up on pressure regulators . . . automatic control valves . . . liquid level controllers, etc. A good way to do this is to take a look at latest types of equipment recommended for the service. We invite you to write for literature describing Davis Valve Specialties. The coupon is for your convenience.

Davis Regulator Co.
2540 S. Washtenaw Ave., Chicago

Without obligating me, please MAIL literature describing:

- ☐ Pressure Regulators and Pump Governors (including service and capacity charts).
- ☐ Pressure Relief, Back Pressure, and Exhaust Relief Valves.
- ☐ Liquid Level Controllers for closed tanks.
- ☐ Lever and Float Operated Valves.
- ☐ Solenoid Valves for Industrial Service.
- ☐ Stop and Check, Non-Return, and Balanced Check Valves.
- ☐ Strainers.
- ☐ A specific problem is outlined on the attached sheet. We would appreciate your recommendations.

Name .....

Company .....

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Town ..... State .....

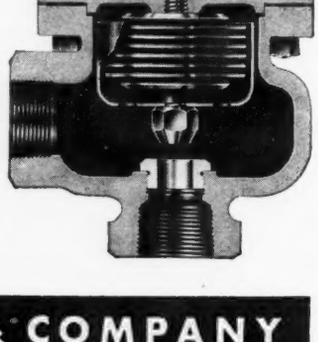
NICHOLSON

CONTROL VALVES FOR LONG, PRESSURE-TIGHT SERVICE

Available in TWO, THREE, FOUR-WAY and Special Types for operating Air, Steam, Water or Oil Cylinders on pressures up to 300 lbs. Made in five different metal combinations to cover all mediums handled. Non-corrosive metals are used in all vital parts. Gaskets and gland packing suitable for each specific service are used.

Nicholson also offers foot, solenoid and motor operated valves and valves for hydraulic service up to 5000 lbs. pressure. Ask for Bulletin 933 describing "Nicholson" Control Valves.

STURDY STEAM TRAPS WITH EXTRA CAPACITY

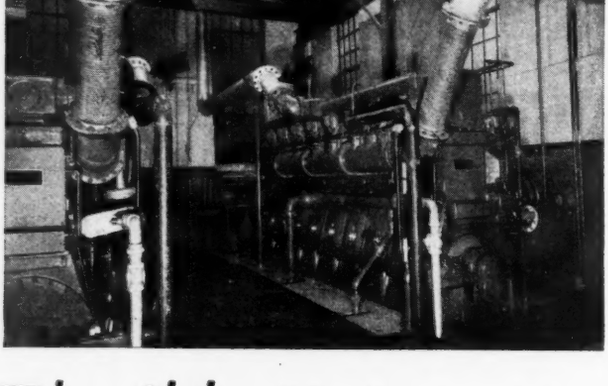


Available in Bronze, Cast Iron and Cast Steel Construction—in sizes from ¼" to 2" and for pressures from vacuum to 300 lbs. with superheat.

Nicholson Industrial Steam Traps are large in capacity, will not freeze, eliminate air binding, require no adjustment, prevent dribbling, provide intermittent discharge and never water-log. In many cases they step up process production from 20 to 30%. Used in leading industrial plants. Ask for Industrial Trap Bulletin No. 439 describing these moderately priced traps.

OTHER NICHOLSON PRODUCTS—NICHOLSON Welded Floats, Piston and Weight Operated Traps, Flexible Couplings, Expanding Mandrels, Arbor Presses, Compression Shaft Couplings, Steam Eliminators and Separators, Compressed Air Traps.

W. H. NICHOLSON & COMPANY
125 OREGON ST. WILKES-BARRE, PENNSYLVANIA, U. S. A.



PENFLEX

Here are a pair of fine 1,000 h.p. Worthingtons, 8 cylinders, convertible for either diesel or gas operation. Viewed from the exhaust end, note also the PENFLEX air intakes indicated by arrows. Both exhausts and intakes are self-supporting. Available in sizes from 1", plain or with patented PENFLEX Air Jacket, here is the one exhaust pipe that you can install and forget. Try it!

Tight as Pipe but Flexible

Flexible Exhausts

Relief from all strains, thermal or mechanical, is provided by the 4-wall interlocking joint construction of PENFLEX Exhaust Pipes. In sizes up to 14" each lineal foot has ⅜" of "come and go", a safety feature that is both simple and economical. Send us a sketch of your most important run.

PENFLEX Bulletin 70

Get the full details in practical diagram and data form. Learn how easy it is to make perfect bends right on the job without special tools. Many other money-saving features, too.

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H.P. Steam Hose in bronze or steel
Heatproof Couplings
Tank Car Hose
Boiler Cleaners
Lube. Lines

. . . . . Pennsylvania Flexible Metallic Tubing Co.
7202 Powers Lane, Philadelphia, Pa.

Cleveland, announcement is also made of appointment of Mr E F Konker as district sales manager. He was formerly a member of the Carborundum sales staff. To fill the position vacated by Mr. Konker, the company has appointed K C Woltz, previously a member of the sales engineering staff.

STRAWS

Pointing the way business winds blow

ARIZONA —— Construction Quartermaster, Fort Huachuca, contracted Enterprise Engine Co, San Francisco, Calif., at $47,096, for furnishing and installing convertible gas-type diesel-generating unit in local power plant.

CALIFORNIA —— Standard Oil Co of California, Inc, 225 Bush St, San Francisco, has approved plans for new natural-gasoline plant at Coalinga, including compressor station, power house, pumping station and other structures. A welded-steel pipeline will be built from Coalinga-Amerada gas-field area to plant site for natural-gas transmission, with capacity of about 20,000,000 cu ft daily. A booster station will be built to maintain this supply, which gasoline plant will be equipped to process. Entire project will cost about $275,000.

Lockheed Aircraft Corp, Empire Ave and Victory Pl, Burbank, plans two 1-story additions for improvements in assembling division, totaling about 40,000 and 28,000 sq ft of floor space, respectively. Cost over $135,000 with machinery and power equipment. John and Donald B. Parkinson, Title Insurance Bldg, Los Angeles, architects.

Glendale will award contract soon for one mechanical draft cooling tower and accessories for municipal power plant. Bids recently received for deaerating-type water heaters have been rejected, and new bids are being taken for such equipment.

Burbank rejected bids recently received for boilers and accessories for municipal power plant, and on new call has low bid from G C Moore & Co, San Francisco, at $74,850 for one unit and $148,200 for two boiler units, each with rated capacity of 120,000 lbs per hr. Contract will be awarded soon. Bids also have been rejected for steam condensing unit for station and new estimates will be received soon.

COLORADO —— Gates Rubber Co, 999 South Broadway, Denver, is considering new power plant at mill, with installation of boiler units using oil for fuel, turbine-generator and auxiliary equipment. Cost estimated over $400,000, with equipment.

CONNECTICUT —— Keith S Heine, 101 Mohawk Dr, West Hartford, architect, has plans under way for 2-story ice-manufacturing and cold-storage plant at Bridgeport, 100 x 290 ft, for company whose name is temporarily withheld. Cost over $80,000, with machinery.

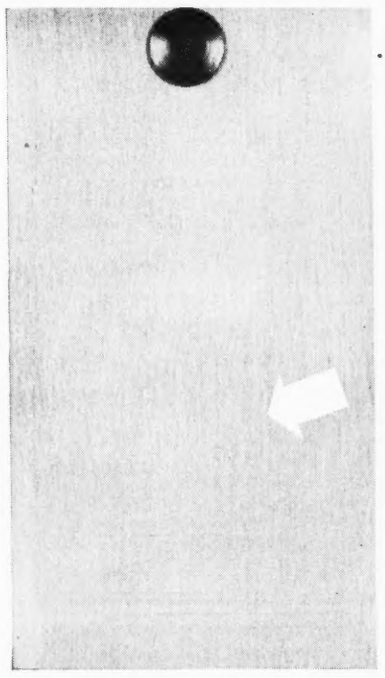
FLORIDA —— Southeastern Pipe Line Co, Atlanta, Ga., has surveys nearing completion for new welded-steel pipeline from Port St. Joe, to Lookout Mountain, near Chattanooga, Tenn., close to 450 mi, for gasoline transmission. A terminal station will be located at last noted place, as well as bulk terminal plant at Atlanta, Ga., which will be on right-of-way of line. Pumping stations will be installed for booster service. Cost estimated close to $5,000,000. Work is scheduled to begin soon. Company is jointly owned and operated by Pure Oil Co, Pure Oil Bldg, Chicago, Ill., and Gulf Refining Co, Gulf Bldg, Pittsburgh, Pa.

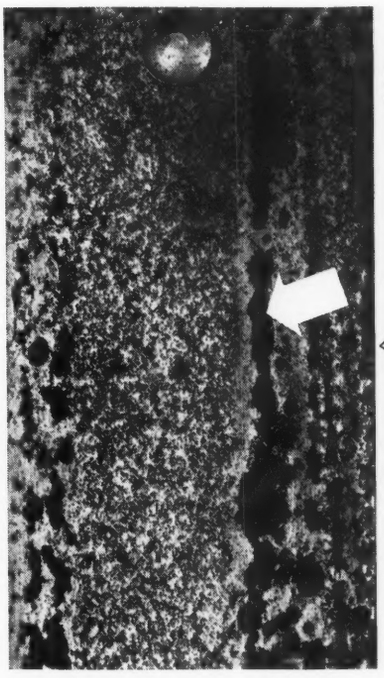
Bureau of Yards and Docks, Navy Dept, Washington, D. C., contracted Industrial Heating & Engrg Co, 828 North Broadway, Milwaukee, Wis., at $95,000, for installation of power house and steam distributing system at new Felton naval base, Pensacola.

ILLINOIS —— Bd of Trustees, University of Illinois, Champaign, has approved plans for new power house at institution, consisting of 1-story boiler room, 72 x 110 ft, and turbine department, 60 x 90 ft. Cost reported over $125,000, with equipment. Proposed to begin work soon. Sargent & Lundy, Inc, 140 South Dearborn St, Chicago, consulting engineer.

Division of Architecture and Engrg Springfield, contracted Wickes Boiler Co,

Use this
IMPROVED SLUSHING COMPOUND
to protect highly finished metal surfaces





Look at the Difference!

These two similar pieces of metal, one slushed with GULF OILCOAT NO. 1 and the other with a conventional slushing compound, were exposed to highly corrosive influences for the same length of time. The superior value of GULF OILCOAT NO. 1 is clearly demonstrated by the perfect condition of the metal plate on the left.

GULF OILCOAT NO. 1 is easily applied, long lasting and economical to use

YOU can now secure an improved material to protect highly finished surfaces of steel and nonferrous metal products against corrosion—GULF OILCOAT NO. 1. This product is an entirely new type of slushing compound, developed by Gulf technologists after many years of research and field tests.

While GULF OILCOAT NO. 1 provides a thin film which is not easily rubbed off by handling, it may be readily removed by conventional solvents. Accelerated laboratory corrosion tests, as well as field tests with all types of metals have established the superiority of this new type of slushing material over products formerly used for this purpose.

GULF OILCOAT NO. 1 can be applied by any conventional method and lasts for a long period of time. It is nominally priced and economical to use. Ask the Gulf representative who calls on you to give you further details—or fill in and mail the coupon below for complete information.

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Gulf Oil Corporation—Gulf Refining Company
Room 3813, Gulf Building, Pittsburgh, Pa.

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YARWAY INVOLUTE SPRAY NOZZLES

Unique Yarway Involute design.

No internal parts or vanes to clog or erode.

Unobstructed flow gives minimum loss of head.

Finely divided spray cone provides rapid cooling.

Renewable orifices adapt nozzles for any service.

Installations total more than 5 million gallons per minute in water cooling and air conditioning service.

Made in both cast and bar-stock types. All sizes from ¼ in. to 2½ in. Write for Catalog N-615.

YARNALL-WARING COMPANY

100 Mermaid Ave. Philadelphia

Saginaw, Mich., at $23,291 for boiler and accessories, and Hoffman Combustion Engrg Co, Detroit, Mich., at $6,499 for stoker, for installation in power house at state school for boys, St. Charles.

Ford Motor Co, 12600 Torrence Ave, Chicago, plans rebuilding of portion of power house at local assembling works, recently damaged by fire. Loss estimated about $25,000, with equipment. Main offices of company are at Dearborn, Mich.

Woodstock contracted Brady Conveyors Corp, Chicago, Ill., for installation of ash-handling system in municipal power plant.

Construction Quartermaster, Savanna, will award contract soon for new steam-generating station at local Proving Grounds.

INDIANA —— Chalmers will award contract soon for one 200-gal. per min. deep-well pumping unit and accessories, and for a 60,000-gal. elevated steel tank and tower, for municipal water system. Martin L Burden, 103½ North Harrison St, Alexandria, consulting engineer.

IOWA —— Mount Vernon Produce Co, Mount Vernon, has approved immediate construction of new 1-story cold-storage and refrigerating plant, with locker system comprising about 240 units. Cost reported about $35,000, with equipment.

Cascade has approved plan for new municipal power plant to cost about $110,000, with diesel-generating units and accessories. Award for power house building has been made to L A Kopp, Rochester, Minn., and erection will begin at once.

Rath Packing Co, Sycamore and Elm Sts, Waterloo, contracted Jens Olesen Construction Co, Waterloo, for 4-story and basement addition to power house at meat-packing plant, 40 x 60 ft, for engine department. Awards for equipment will be made separately. Cost reported over $85,000. Henschien, Everds & Crombie, 59 East Van Buren St, Chicago, Ill., architects and engineers.

Story City recently awarded the contract for improvements to municipal light and power plant, including a diesel-generating unit, cooling tower, etc, to Fairbanks, Morse & Co, at $26,097. R W Gearheart, 349 21st St, S E, Cedar Rapids, Iowa, consulting engineer.

KANSAS —— Winfield will take bids soon on a feed water heater with auxiliary piping for the municipal power plant. Estimated cost $5,000. Black & Veatch, 4706 Broadway, Kansas City, Mo., consulting engineers.

KENTUCKY —— Wiedemann Brewing Co, Columbia St, Newport, has approved plans for modernization in power house, with installation to include new 4000 sq ft watertube boiler and accessories, stoker, etc. Contract has been let to Alphons Custodis Chimney Construction Co, New York, N. Y., for remodeling present radial brick stack at station. Entire project will cost over $50,000. Fosdick & Hilmer, Union Trust Bldg, Cincinnati, Ohio, consulting engineers.

Louisville Gas & Electric Co, Louisville, is arranging fund of about $125,000 for replacements in pipeline system for gas distribution and gas plant facilities.

MASSACHUSETTS —— Bird & Son, Inc, East Walpole, manufacturer of wall board, building papers, etc., has approved plans for 1-story addition to mill, 30 x 500 ft. Cost estimated over $125,000 with machinery and power equipment. Erection will be placed under way at once.

MICHIGAN —— Watervliet will take bids soon for proposed municipal power plant, to be constructed as a joint enterprise of city, Village of Coloma, and Watervliet and Coloma Townships. New station will have capacity for furnishing power requirements of all four areas. Ayres, Lewis, Norris & May, Wolverine Bldg, Ann Arbor, consulting engineers.

Construction Service, Veterans' Administration, Washington, D. C., contracted Drake-Avery Co, 147 West Woodbridge St, Detroit, for addition to boiler plant at institution at Dearborn.

Twin City Packing Co, Menominee, contracted Menominee Boiler Works, Menominee, for boiler unit and stoker for installation in new boiler house on plant, on which work will be placed under way soon. Awards for brick or steel stack and other equipment will be placed soon. Derrick Hubert, 1055 Sheridan Rd, architect.

Bd of Zilwaukee Township Commissioners, Zilwaukee, plans early purchase of motor-driven pumping machinery and accessory equipment, and elevated steel tank and tower for water system. Francis Engrg Co, Saginaw, consulting engineer.

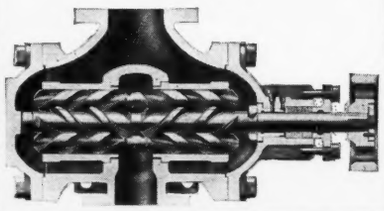
MINNESOTA —— Moorhead will award

solves the problem

That De Laval-IMO Oil Pumps are giving satisfaction is proved by the fact that the great majority of users send us repeat orders. Our study of your fuel oil burner, hydraulic pressure, or lubricating oil pumping problem will cost you nothing, and we know that once you have used an IMO, you will become an IMO booster.

Publication I-52 sent upon request

DE LAVAL STEAM TURBINE CO.
TRENTON, N. J.



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Seamless Copper
FLOATS

GUARANTEED TO STAND UP!

Every Hercules Float carries our guarantee to stand up under 350 lbs. working pressure and 500 degrees temperature.

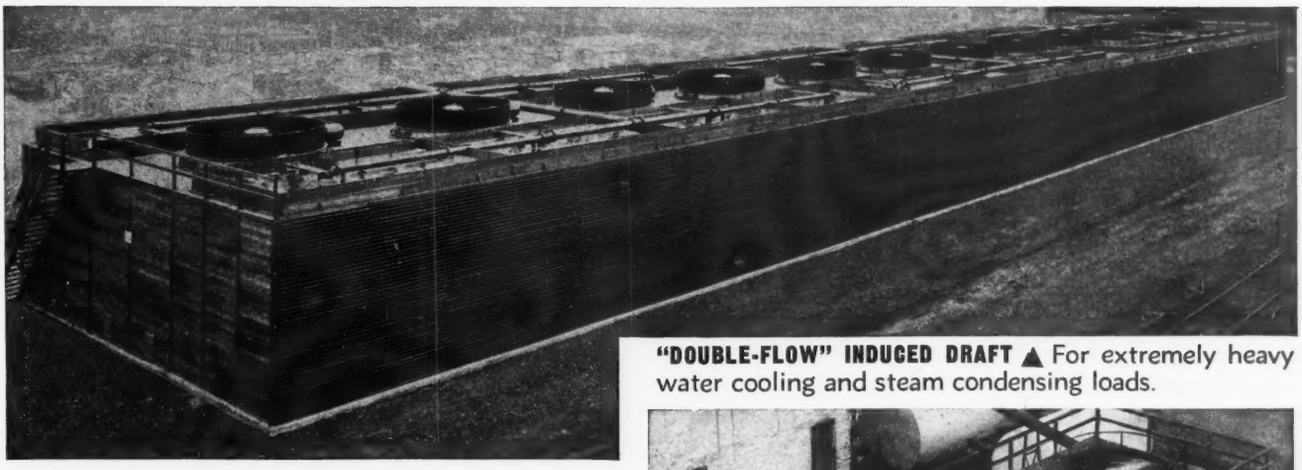
Fabricated of seamless copper under our special spinning process, Hercules Floats are uniform in thickness and high in mechanical strength.

You can depend on Hercules for floats—in standard shapes up to 10 in. and in special types to your specifications—to give long, dependable, economical service.

Insure care-free maintenance of water level in your heaters, tanks, reservoirs and other equipment by specifying "HERCULES."

HERCULES FLOAT WORKS
200 Franklin St.
SPRINGFIELD, MASS.

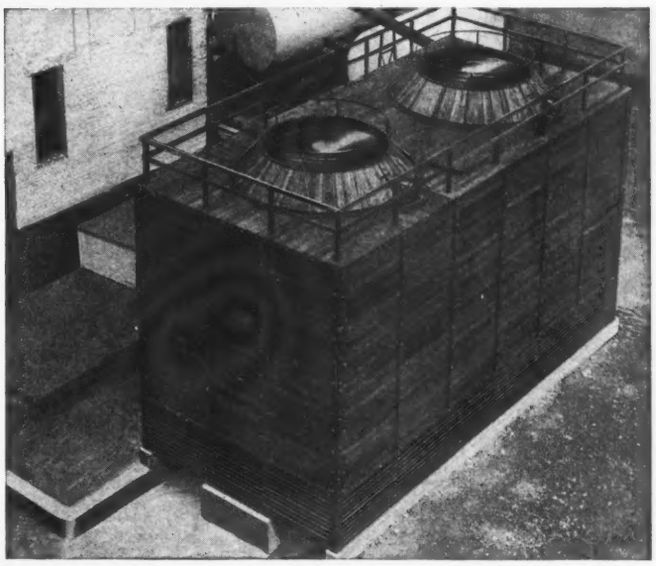
MARLEY the *Complete* Line of COOLING TOWERS for 1940



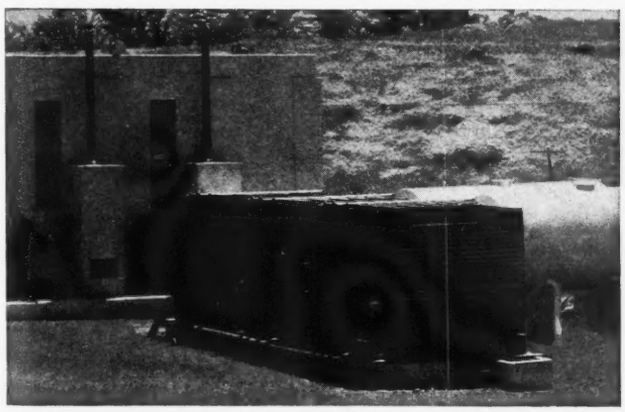
"DOUBLE-FLOW" INDUCED DRAFT ▲ For extremely heavy water cooling and steam condensing loads.

Even Greater Performance and Economy at Less Cost!

Marley engineering has made the cooling tower's advantages and savings available to an almost unlimited range of applications from very small to the largest. Marley's well known structural, mechanical and operating characteristics bring owners unequalled performance, dependability and long life. Yet many models are reduced even from 1939's low prices.



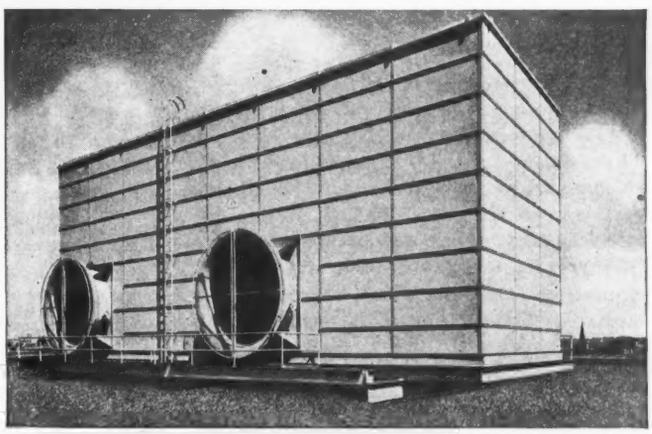
"STANDARD" INDUCED DRAFT ▲ and FORCED DRAFT ▼ For any capacity in any kind of service. Either type furnished in Redwood or steel.



ATMOSPHERIC SPRAY TYPE ▲ For cooling engines, compressors, condensers, etc. Also equipped with coils for closed-system or "indirect" cooling.

also: ATMOSPHERIC DECK TYPE TOWERS for all heavy industrial water cooling services.

and: SPRAY PONDS and all accessories including louvered fence for prevention of wind drift.



Marley *Non-Clog* SPRAY NOZZLES

with Patented Side-Injection

ALL TYPES for Air Washers, Brine Spraying, Atmospheric Condensers, Cooling Towers, Humidifying, Ice-Melting, etc. Many sound reasons why they lead in sales and installed capacity.

THE MARLEY CO., 3001 Fairfax Rd., Kansas City, Kans.
Gentlemen: Send attractive illustrated literature on—

☐ COOLING TOWERS for.....

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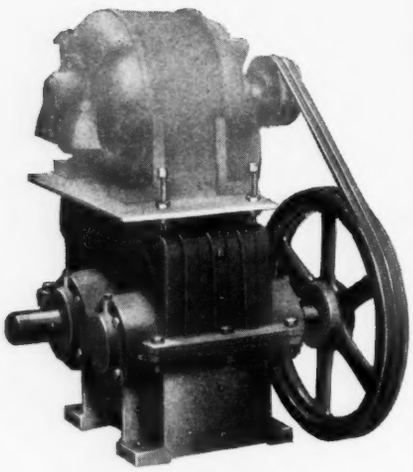
Save on Motors..
BY USING

SACO
SPEED REDUCERS

Adjustable First Reduction Thru V-Belts Permits Use of Any Standard, Full Speed Motor . .



The SACO overcomes the objection production engineers have to special speed or gear motors. By using proper size V-belt sheaves, the SACO can be used with practically any standard, full speed stock motor to give required output speed. SACOS are *noiseless* in operation. They require less floor space and less supporting structure than other reducers. *And they are over 90% efficient.*

FREE TO INTERESTED USERS OF SPEED REDUCERS—
Catalog 7838 . . . with complete data. Output speeds 14 to 176 RPM. Write for your copy!

STEPHENS-ADAMSON MANUFACTURING COMPANY
6 RIDGEWAY AVE.
AURORA, ILLINOIS

contracts soon for new 3000-kw turbine-generator, condenser and auxiliary equipment for installation in municipal power plant, where improvements will be made. Cost about $200,000. Helmick, Edeskuty & Lutz, Essex Bldg, Minneapolis, consulting engineers.

Bd of Trustees, University of Minnesota, Minneapolis, R S Callaway, Administration Bldg, purchasing agent, will receive bids until Feb. 15 for two new boiler units, each with rated capacity of 30,000 lbs per hr, to be installed in University Farm power plant, using pulverized coal as fuel, including water walls, air preheaters, superheaters, forced and induced draft fans, steel encased settings, pulverizing equipment and galleries. W F Holman, supervising engineer, Dept of Buildings and Grounds, Administration Bldg.

MISSISSIPPI —— Natchez contracted New Orleans Electric Engrg Co, 741 St Joseph St, New Orleans, La., at $50,870 for diesel-generating unit and auxiliary equipment for installation in municipal power house and waterworks station. Wiedemann & Singleton, Candler Bldg, Atlanta, Ga., consulting engineers.

Noxubee County Refrigeration Association, Macon, recently organized as an affiliation of Four-County Electric Power Association, Macon, plans 1-story cold-storage and refrigerating plant, including locker system with 200 units. Cost about $25,000. Financing has been arranged through Federal aid.

MISSOURI —— Missouri Pacific Railroad Co, 13th and Olive Sts, St. Louis, in co-operation with three other railroads, is planning large multi-story terminal for perishable food products at Kansas City, where site has been selected, with cold-storage and refrigerating plant. Cost estimated about $760,000, with equipment, and of which Missouri Pacific will contribute $265,000.

Bd of Public Service, St. Louis, contracted Erie City Iron Works, Erie, Pa., at $20,466 for boiler unit and auxiliary equipment for installation in power house at Robert Koch hospital (Contract 5008); also, made award to Laclede Stoker Co, 4438 Hunt Ave, St. Louis, at $17,448 for stoker and auxiliary equipment for same plant (Contract 5009). Another contract has been let to Sodeman Heat & Power Co, 2306 Delmar Blvd, St. Louis, at $43,286 for installation of a refrigerating plant in former laundry building at same institution.

Monsanto Chemical Co has awarded the contract for a $75,000 power house building to the Fruin-Colnon Contracting Co, 502 Merchants Laclede Bldg, St. Louis. Plans for the building, prepared by Stone & Webster Engrg Co, call for a building 1-story (65 feet high) 55 by 70 feet and of brick and steel construction, with composition roof. It is to be erected in the rear of 1828 South Second St, St. Louis, Mo.

MONTANA —— United States Engineer Office, Kansas City, Mo., contracted Allis-Chalmers Mfg Co, Milwaukee, Wis., at $545,700 for furnishing, delivering, installing and testing one 16,667-kva, and one 38,889-kva ac generating unit and accessory equipment for hydroelectric power station at Fort Peck.

Richfield, plans improvements in municipal power plant, including installation of additional equipment. Estimates of cost are being made. Black & Veatch, 4706 Broadway, Kansas City, Mo., consulting engineers.

NEBRASKA —— Nebraska Hydro-Electric Power Co, Inc, St. Paul, recently organized, has taken over former hydro-electric generating plant of Northern Nebraska Power Co, at Spencer, inactive for a number of months, and will modernize and improve, including installation of new turbine-generator units and auxiliary equipment. Company has secured permission to issue bonds and stock totaling $415,000 to carry out project. New organization is headed by Harold E Wood and Frank J McArthur, Spencer.

Roberts Dairy Co, 2901 Cuming St, Omaha, has approved plans for new 1-story milk products and dairy plant. Cost over $150,000 with machinery and power equipment. Completion is scheduled early next summer. Gordon Roberts, executive vice-president, in charge.

Black Brothers Milling Co contemplate the erection of a power plant on the Blue River at Beatrice, to cost about $50,000.

NORTH DAKOTA——Nodak Rural Electric Co-operative, Inc, Grand Forks, E A Walters, secretary-treasurer, plans power plant on local site for power supply for rural electric system. Initial installation will include three diesel-generator units,

Babbitt
Adjustable
SPROCKET RIM
with Chain Guide

KEEP YOUR MEN OFF LADDERS— control valves from the floor

With Babbitt Sprocket Rims on your overhead valves, you can control valves instantly from the floor. Far quicker and safer than climbing ladders.

Babbitt Rims are easily attached in a few minutes, are inexpensive and assure safe, positive and instantaneous overhead valve operation. Available for valves of every make or style. Write for details.

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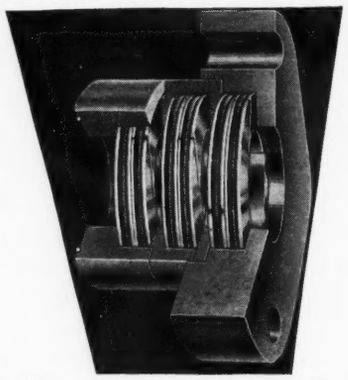

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France is "full-floating" metal packing for piston rods and valve stems in any type of engine, pump or compressor. Prevents rod scoring and provides maximum sealing efficiency under any condition of speed, pressure or temperature. Write for details.

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NOTICE
This advertisement is one in a series which gives you the basic reasons for the present nationwide use of APEXIOR on boiler tubes and drums. The final advertisement in the series will be an evaluation in terms of dollars and cents — based upon the experiences of many industrial and utility operators.

4 REASONS

for specially-prepared metal

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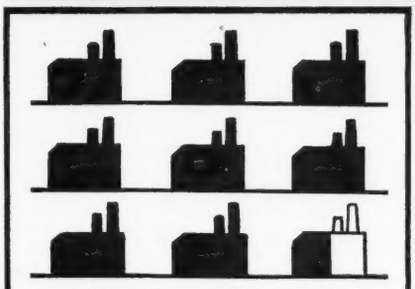

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KEEPS BOILERS CLEAN LONGER

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As a **PURELY MECHANICAL METHOD** of supplemental maintenance of boiler steel, APEXIOR has proved its importance —in lower cost of boiler housekeeping and longer metal life.

APEXIOR — brush-applied to new metal after removal of mill scale:

(1) keeps the metal surfaces *new* under the coating
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All boiler manufacturers will quote on the preparation of tubes and drums for APEXIOR, and will also handle the application of APEXIOR, under Dampney Company supervision if desired. Make the following your Standard New Work Specification:

"The boiler manufacturer shall furnish tubes which are suitable for the application of APEXIOR. Internal drum surfaces shall be prepared by abrasive blasting. APEXIOR coating shall be applied to all internal tube and drum surfaces under competent supervision after boiling out and before operation."

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WITH THE

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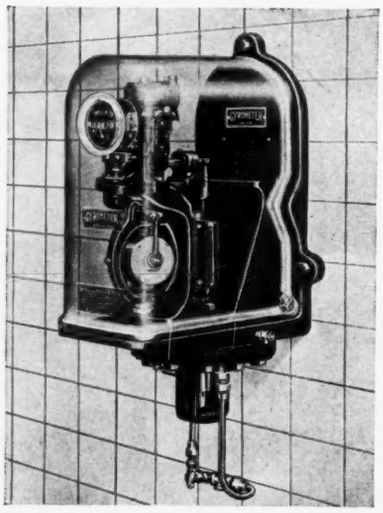

In balancing a differential head applied to a diaphragm unit by means of gyroscopic couple forces, the GYROMETER insures accurate, *straight line* totalization of fluid flows.

Although unique in design, its simple construction insures freedom from maintenance and operating details.

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each about 100-kw, with provision for two additional units of same rating at later date. Cost of entire project, including transmission and distributing lines, about $225,000. Financing has been arranged through Federal aid. Ellerbe & Co, First National Bank Bldg, St. Paul, Minn., consulting engineers.

Kinston has plans maturing for improvements in municipal power plant and water system, including installation of additional equipment. Bond issue of $300,000 has been authorized for work.

Arthur Johnson and Thomas Brekke, Ray, are heads of a local committee to make surveys and estimates of cost for a proposed cold-storage and refrigerating plant, with locker system.

NEW JERSEY——Electric Boat Co, 40 Wall St, New York, N. Y., has approved plans for main 1-story addition, 200x400 ft, and several smaller units at Elco Works, foot of North St, Bayonne, for construction of motor torpedo boats and submarine chasers for United States Navy. Completion is scheduled next spring. Cost about $600,000 with machinery and power equipment.

Elastic Stop Nut Corp, 1001 Newark Ave, Elizabeth, plans 1-story plant on tract of land, 400 x 750 ft on Vaux Hall Rd, Union, recently acquired, reported to cost over $60,000, with machinery and power equipment.

Atlantic City Electric Co, Atlantic City, plans improvements in steam-electric generating plant, including installation of new 25,000-kw turbine-generator and auxiliary equipment, high-pressure boiler and accessories. Work is scheduled to be carried out this year.

OHIO —— Construction Quartermaster, Wright Field, Dayton, will award contract soon for wind tunnel for aircraft testing service at local field, consisting of a test chamber 60 x 106 ft and 62 ft high; power building, 51 x 94 ft; and tunnel duct structure. Project is estimated to cost $2,000,000, of which about $1,500,000 will be expended for equipment, for which awards will be made separately. Stone & Webster Engrg Corp, 49 Federal St, Boston, Mass., consulting engineer.

National Biscuit Co, 449 West 14th St, New York, N. Y., plans additions to branch plant on Paine Ave, Toledo. Cost reported over $500,000 with traveling ovens, conveyors, loaders and other mechanical equipment. Company is negotiating with city officials for permission to close thoroughfare noted to Maumee River line to provide site for new structures. Louis Wirsching, Jr, company engineer, first noted address.

Water Dept, Toledo, closes bids Feb 28 for two main pumping stations for new water supply project from Lake Erie, now under way, consisting of high-pressure pumping plant at Collins Park, and low-pressure pumping station near intake at Reno Beach, estimated to cost $800,000 and $600,000, respectively, with pumping machinery and complete auxiliaries. George N Schoonmaker is city manager, in charge.

Old Fort Mills, Inc, Marion, plans rebuilding of portion of soy bean processing mill recently damaged by fire. Loss estimated close to $135,000 with machinery and power equipment.

Ohio Public Service Co, Hanna Bldg, Cleveland, plans improvements in boiler plant at steam-electric generating station at Alliance, including installation of new coal and ash-handling machinery and other equipment. Proposed to begin work soon. C C Henderson, 526 East Main St, Alliance, vice-president and division manager, in charge.

Ohio Power Co, Newark, has plans under way for improvements in steam-electric generating station at Philo, with new 80,000-kw turbine-generator and accessories, high-pressure boilers and auxiliary equipment. Project will be carried out in 1940.

Amherst plans installation of following equipment in new municipal power plant, for which awards are scheduled to be made in near future: Two 3,000-sq-ft. multi-drum, bent-tube boilers, equipped with single retort underfeed stokers and all accessories; two duplex boiler-feed pumps, each with capacity of 20,000 lb per hr; feedwater heater, coal and ash-handling equipment and complete auxiliary boiler room equipment; two 500-hp steam-engine-driven electric generators with accessory equipment; switchboard, wiring, etc.; high and low-pressure piping, valves and all necessary miscellaneous equipment. Contract also will be let soon for station building, 40 x 77 ft. Project will cost about $145,000. Floyd G Browne, Marion, consulting engineer.

OREGON——Beaver Portland Cement Co, Lumberman's Bldg, Portland, con-

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Model W
Figure 1000

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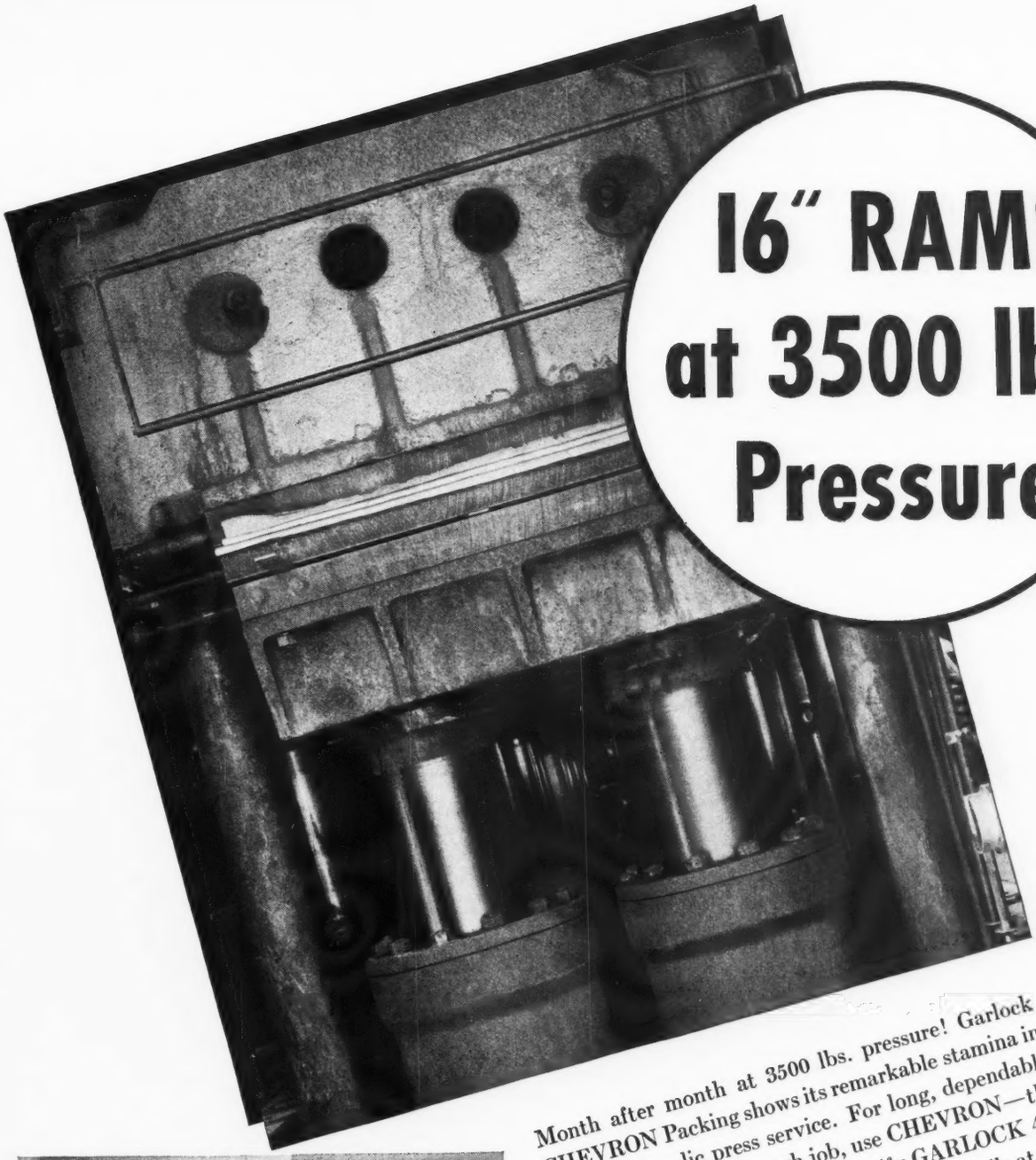

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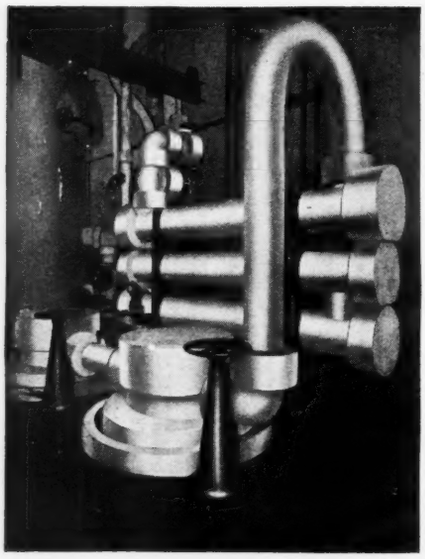

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BOILER WATER CONCENTRATION CONTROL SYSTEMS

tracted R I Stuart & Sons, Medford, for construction of hydroelectric power plant on Rogue River, near Gold Hill, including wing dam extending 400 ft in river, power plant building, canal structure and miscellaneous construction. Station will be equipped for initial capacity of 1500-kw., and will be used for power supply for mill at Gold Hill. Cost estimated at $150,000.

PENNSYLVANIA——Williamsport Planing Mill Co, Williamsport, is considering new boiler house in connection with proposed rebuilding of portion of woodworking plant, recently destroyed by fire. Loss reported in excess of $100,000.

Sun Oil Co, 1608 Walnut St, Philadelphia, plans modernization in oil and gasoline refining plant at Marcus Hook, near Philadelphia, with group of 1 and multi-story buildings for complete new refinery unit, steel tank storage division, pumping station and other departments. Entire project will cost about $6,500,000 and is scheduled to be carried out in 1940.

Chester Housing Authority, 10 East Fifth St, Chester, Edward D McLaughlin, chairman, plans central-heating plant for new local housing development consisting of 400 dwelling units. Entire project will cost about $1,250,000. David H Morgan, 1512 Walnut St, Philadelphia, architect.

Bethlehem Steel Co, South Bethlehem, plans 1-story addition to wire rope division plant at Williamport, 80 x 425 ft. Cost estimated over $150,000 with machinery and power equipment.

SOUTH CAROLINA——Southern Kraft Corp, 220 East 42nd St, New York, N. Y., a subsidiary of International Paper Co, same address, plans improvements in pulp and paper mills at Georgetown, and Springhill, La., used for kraft paper and container board production. Capacity at both mills will be increased by 330 tons per day. Cost estimated about $750,000.

Timber Lake has authorized new municipal power plant and will have plans prepared at early date. Estimates of cost are being made. Proposed to use diesel-generating units and accessories.

TEXAS——Shell Oil Co, Inc, Shell Bldg, Dallas, contracted Charles G Heyne & Co, 2002 Rothwell St, for installation of air-conditioning system in 22-story office building, including plant unit of 700-ton capacity; also let contract for cooling tower to Marley Co, Kansas City, Kan. Cost about $300,000. Leo S Weil and Walter B Moses, Inc, 427 South Peters St, New Orleans, La., engineer.

San Augustine is completing plans for improvements in municipal power plant, including installation of new 300-kw diesel-generator and auxiliary equipment. H B Gieb & Co, Mercantile Bldg, Dallas, consulting engineers.

Trinity Universal Insurance Co, Construction Bldg, Dallas, plans central-heating plant and air-conditioning system in new 10-story office building on local site at Main and Harwood Sts, where property has been acquired. Cost about $500,000.

Rockport plans natural-gas distribution system, with control station and other operating facilities. Also new welded-steel pipeline for connection with supply source. Work scheduled to be carried out early this year.

Coleman contracted A M Lockett Co, Magnolia Bldg, Dallas, for 500-hp water-tube boiler and auxiliary equipment for installation in municipal power plant, where improvements will be made. Award will be made soon for new 750-kw turbine-generator unit and other equipment. Terrell-Bartlett Engineers, Inc, Smith-Young Tower Bldg, San Antonio, consulting engineer.

WASHINGTON——Continental Can Co, 100 East 42nd St., New York, N. Y., plans new branch plant at Walla Walla, where site is being secured, to consist of several 1-story units, power house and miscellaneous mechanical structures. Cost estimated close to $500,000. Work is scheduled to begin late in spring.

Sunnyside plans early call for bids for pumping machinery and accessories, with automatic control system, for pumping station for water system. G D Hall, Yakima, Wash., consulting engineer.

WISCONSIN——Northern States Power Co, Eau Claire, contracted Lovering Construction Co, 389 East Eighth St, St. Paul, Minn., for erection of superstructure for new steam-electric generating plant at LaCrosse, on which work will proceed at once. Contracts for equipment are being awarded separately. Plant will have initial capacity of 10,000-kw, and is estimated to cost about $1,560,000. Public Utility Engrg & Service Corp, 231 South LaSalle St, Chicago, Ill., consult-

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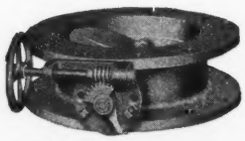

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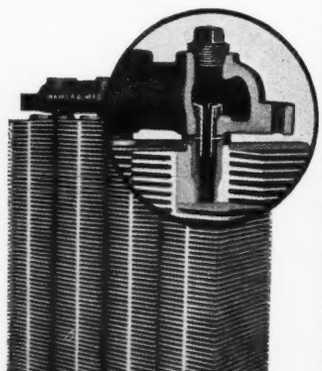

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Hospitals need an abundance of hot water... water without a trace of rust. Besides, limited operating budgets make it desirable to have heating equipment that gives complete freedom from periodic rust repairs. That's why so many hospitals select storage heaters with shells of non-rust Everdur Metal.

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All over the country—in schools, mills, laundries and various institutions—rustable heaters are being replaced by long-lived heaters of Everdur Metal. Here are the facts: Nowadays more Everdur tanks and heaters are sold in a week than were built in the entire year 1929.

Everdur—Anaconda's copper-silicon alloy—is rustless, strong, welds readily and is moderate in cost. For non-rust tanks and heaters of all types, consult the leading equipment manufacturers. Remember the name—*Everdur Metal.*

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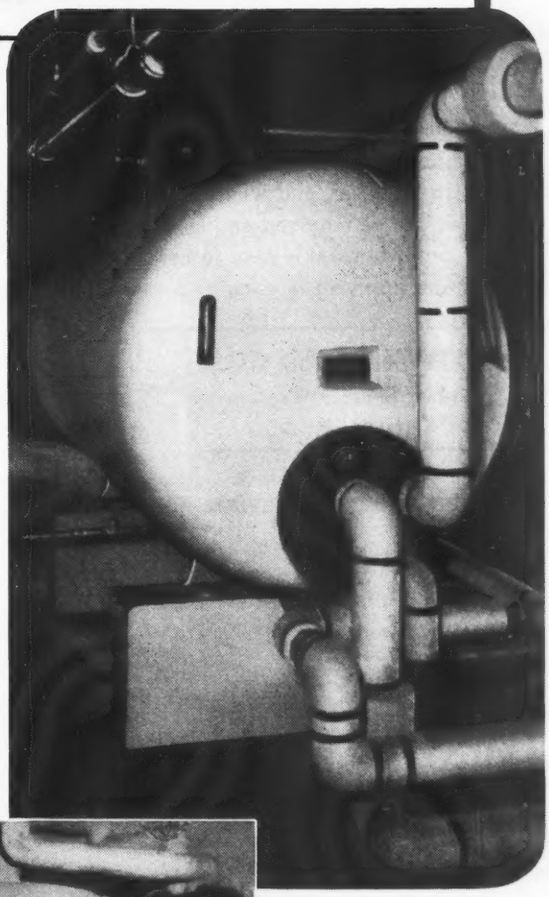
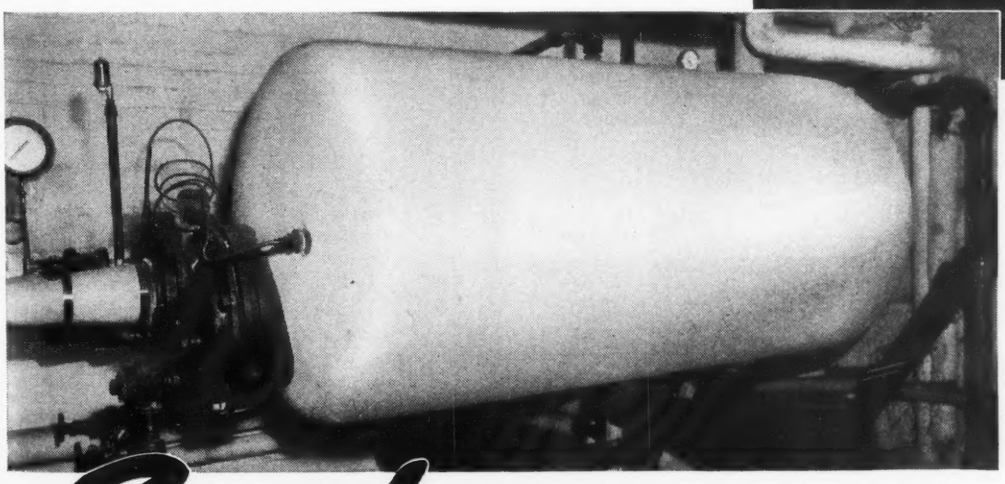


Whitlock Everdur Type "K" storage water heater installed at Pawtucket Memorial Hospital, Pawtucket, Rhode Island



The Exeter Hospital, Exeter, N. H., gets its rust-free water supply from the same type Everdur heater made by the Whitlock Coil Pipe Company, Hartford, Connecticut

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ing engineer.

Peavey Paper Products Co, Inc, Ladysmith, plans improvements in local hydroelectric power plant, owned by Lake Superior District Power Co, Ashland, and operated by first noted company under lease. Installation will include a new turbine-generator unit and complete accessory equipment. Cost estimated at $150,000. State authority has been secured to proceed with project.

Pet Milk Co, Sparta, has approved plans for addition to power house at local plant, for improvements in boiler and engine divisions. Additional equipment will be installed.

WYOMING——Star Valley Power & Light Co, Afton, has approved plans for new power plant on local site, for which superstructure will begin at once. Cost estimated close to $100,000.

TERRITORIES——Chamber of Commerce and Prince William Sound Fishermen's Union, Cordova, Alaska, are at head of project to construct and operate a local cold storage and refrigerating plant for fish foods. Cost estimated at $135,000, with machinery. Financing is being arranged.

Bureau of Yards and Docks, Navy Dept, Washington, D. C., contracted Hahn Engrg Co, 30 Church St, New York, N. Y., at $22,355 for coal and ash-handling systems with receiving hopper, feeder and crusher, bucket elevator, etc, for installation in power plant at navy yard, Pearl Harbor. Hawaii. (Specifications 9466).

Bureau of Yards and Docks, Navy Dept, Washington, D. C., has low bid from Worthington Pump & Machinery Corp, Harrison, N. J., at $38,944 and $54,344 for diesel-generator units and accessories for installation at Guantanamo, Cuba, and Cavite, P. I., respectively. Award is scheduled to be made soon.

Current Comment

Close That Stack Damper

IN TOO MANY industrial plants the boiler room is looked on as a necessary evil. No one does much thinking about operating methods that might cut the coal bill because to someone who doesn't know much about it, the easiest way seems to lie in buying cheaper coal. This may help, but many times the total cost of operating methods is increased rather than reduced.

During the past few years, I have studied many industrial plants with the single idea of reducing operating cost with the equipment on hand. Experience shows that in nine out of every ten plants the boiler damper is left wide open. The amount of heat that goes up the stack due to this negligence represents 15 to 30% of the coal bill. This condition goes without notice because the stack is clear and the fireman is satisfied if he can hold the gage pointer at the desired amount of pressure.

At light loads the loss is greatest. However, many plants have found it difficult to carry the peak load due to the fact that the stack-damper position causes too much air to filter through the setting. There are many devices on the market today that will maintain the proper damper setting and they can easily pay their way.

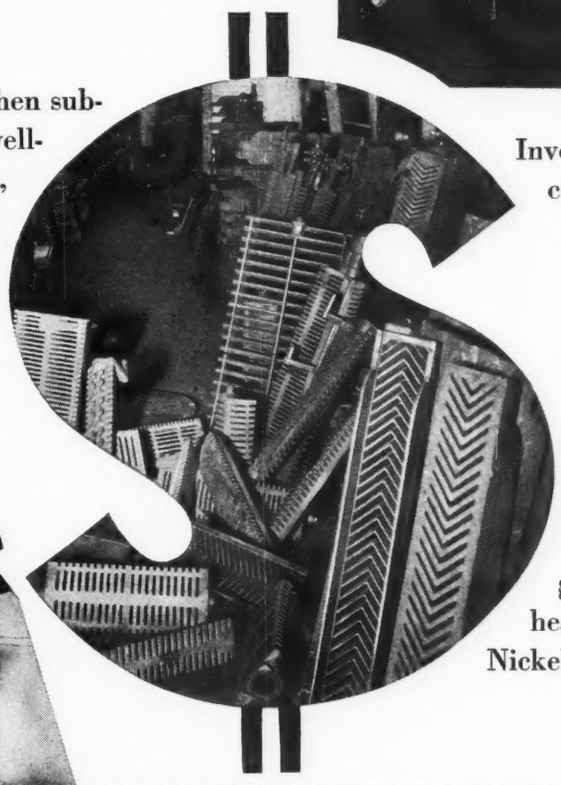
Were one asked for a slogan that would help most in cutting the coal bill, I think it would be "Close That Stack Damper!" If the stack damper is kept at the proper position it will cut the coal bill more than any purchasing agent can by getting good prices on poor coal.

Cleveland, Ohio R A SPENGLER

GREAT SAVINGS *from* GRATE BARS

that resist "growth", scaling and warping

Cast iron literally "grows" when subjected to intense heat. This swelling and scaling causes warping, clogs grates and jams their action, particularly in stokers. Growth, warpage and scaling of Nickel-chromium cast irons is less than half that of plain grey iron.



Investigations of growth tendencies of cast iron indicate marked improvements can be obtained by the use of fine grained irons produced with additions of Nickel and chromium. Designed to maintain resistance to cracking as well as provide a tough, adherent, impenetrable scale, grate bars such as these resist heat, last longer when made of Nickel-chromium cast iron.

Grate bars of **NICKEL** *Chromium cast iron*

Reasons why building managers cut grate costs due to growth and warping are simply explained in this illustrated folder, "Nickel-Chromium Cast Iron Grate Bars and Stoker Parts Provide Longer Life". Write for your free copy today. Incidentally, your consultation is invited regarding money-saving applications of all types of Nickel alloys.

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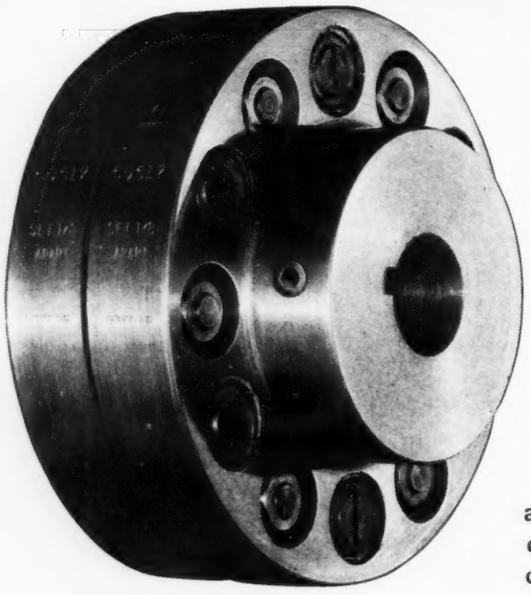

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Readers' Problems

(*Continued from page* 107)

Surge Tank Will Do the Trick

IT LOOKS AS IF JGW depends entirely on the pump air chamber to cushion the system, which is not a very desirable arrangement. Sometimes putting a tee in the discharge near the pump, (with the branch facing up, and carrying a 3 or 4 ft length of capped pipe, will help.

The surest remedy, however, is installing a surge tank in the discharge circuit and operating the pump with an automatic pressure-control valve. Cylinder heads of the water end can be drilled and tapped for small air-intake valves which can be adjusted to keep the surge tank filled with about ⅓ air and ⅔ water. Or a small air pump can be attached to the piston of the main pump to supply the needed air. Speed of the big pump automatically governs speed and output of the air pump. This arrangement makes what is practically a pneumatic water supply system. It will not only absorb pulsations of the pump but will also provide for automatic control at periods of maximum and minimum water demand.

Ansonia, Conn. W T ESTLICK

Pointers on Air Chambers

MORE THAN 25 YEARS experience in power plants ashore and afloat taught me that air chambers, as usually furnished with pumps, work well enough where speeds and pressures are comparatively low. But when speeds and pressures increase and pipelines are longer, these air chambers are of little value. On several occasions I have had to build special chambers to suit local conditions.

The volume of an air chamber depends on the pressure fluctuations, and while it is true that an air chamber hardly can be made too large, for construction reasons it is better to make it no larger than necessary. For instance, in boiler-feed service, where discharge is measured by meters of the orifice or venturi type, pressure fluctuations should be eliminated almost entirely, and should not be more than 1%.

Several other points have to be observed to assure effective operation of an air chamber: (1) it must be installed as close as possible to the discharge side of the pump. Where for practical reasons it can't be mounted on the valve cover, it should be placed in the discharge outlet, by means of a tee. (2) The connection between the air chamber and the pump should be at least the same size as the discharge outlet, preferably a size larger. (3) The chamber should have a gage glass so located that it will show half full when the air chamber is one-quarter filled with water. (4) Some means of charging with air should be provided.

Branford, Conn. G C W GOLEM